POWER

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Was It Worth It?

GENERAL FRANK T. HINES, veterans' administrator, predicts that by the year 1953 the cost of veterans' relief will have totaled $21,000,000,000, and this is only one item of the financial hangover from the war.

It is probably a moderate estimate that our post-war expenditure for the last conflict will amount, in the long run, to $100,000,000,000.

We are still paying large sums in pensions and otherwise as the result of the Civil and Spanish wars.

But this tremendous draft upon our national income is but a small part of the sacrifice.

You have been in a hospital and been racked by the sight and sound of human suffering, mitigated as it is by all the resources of medical and surgical science and skill.

Can you realize the agony of mutilated men lying unattended on a field of carnage, listening to one another's shrieks and groans, and begging for death to relieve their torture?

Have you known the sorrow of the passing of a loved one, the shock of a death notice, the desperate woe of an eternal parting; the vacant chair, the loss of the protector and breadwinner?

Multiply all of this bereavement, this violated affection, the wreckage of careers, the blighting of hope, lives doomed to the eternal shadow of broken ties and tragic memories by the thousands of hearts and homes that it touches, and what is there in all the mad schemes of ambitious rulers, in all the anticipation of their glory-seeking followers that warrants a tithe of it?

We are all getting misery enough out of the revelry of murder. Who, except the profiteers got any good out of it?

F. R. Low

EDITORIALS

Charge It!

THE IDEA of metering power services to consuming departments is taking hold. Some have done it for years—with profit.

No easier way to turn an honest penny has ever been devised. Even a poorly engineered plant, badly run, should profit by metered services. The unit cost may stay up, but fewer units will be used, and the power service cost per unit of factory output will go down.

This is not to undervalue the installation of intelligence along with the meters. The mere existence of a distribution meter on the steam line to the process department is undoubtedly an incentive to economy in use, but the incentive is greater if the department head receives a "pink slip" calling his attention to the quantity used. And it is still more effective if the steam carries a unit price at which he is billed for his actual consumption.

One fine plant, recently visited by a member of the *Power* staff, does the thing up brown. Meters are checked yearly by a reputable outside laboratory. The bills, submitted to the departments must be paid—with money. Here is realism—and savings that would warm the heart of any executive.

Rate Reductions Discredit Gov. Pinchots Broadside

LAST WEEK came the announcement of the New York State Public Service Commission that the new electric rates initiated by the public utilities had been made effective at once in New York City. A few hours later the newspapers of the country gave front-page display to the speech of Governor Pinchot of Pennsylvania at the Governors' Conference at French Lick, Ind., in which he forcefully stated his opinion that public utilities' rates were "the most gigantic graft ever imposed or collected by any single business since the world began." He made numerous other comments indicative of his state of mind, but this is sufficient to show his viewpoint.

How, in the spirit of fair play, anyone could make such a sweeping statement, it is impossible to understand. It is so extravagant that it cannot be accepted by thinking people. There are probably instances of poorly considered policies among the public utilities. In this they are no different from other businesses, nor individuals for that matter. But there are also many public utilities, businesses and individuals not deserving of the misleading arraignment Governor Pinchot would wish upon them.

The New York Edison Company and its subsidiaries had to submit to all sorts of abuse from outside interests during the public meetings at which its offer to reduce rates was heard.

It is estimated that the new rates will save five and one-half million dollars in consumers' bills, and the public utility had to fight hard to put the reduction through. Does this attitude warrant Governor Pinchot's broadside?

The governor's words would command more respect if they hewed closer to the line.

Boiler Progress At Gennevilliers

BOILERS now being installed at the Gennevilliers station of Paris, France, and described elsewhere in this number, should be of considerable interest to American engineers. Representing the latest French practice for peak-load stations, they combine, so far as can be determined, simplicity, efficiency, ease of operation, low first cost and economy of space. All of these advantages are claimed by their French users and would seem to be the natural outcome of the very interesting design employed.

This design reflects, in part, the fact that Gennevilliers station, erected in 1922 as the last word in French construction and one of the world's largest power plants, has handed on much of its base load to the new Vitry station. At Gennevilliers the new boiler installation, needed to swing the 340,000-kw. peak load, must fit its new rôle by the lowest first cost consistent with ease of operation and reasonable efficiency.

Ten boilers are now being installed with a capacity of 300,000 lb. of steam per hour. These replace the fifteen original boilers.

So far as one may judge from appearances, the unique design, notably simple and direct, is a fine example of

the application of French logic to an engineering structure. Gases traverse the tubes in a single pass, which converges rapidly to allow for contraction with cooling. An ingenious arrangement of inclined tubes, with vertical and inclined headers, creates a natural path for unimpeded circulation.

Perhaps the most significant feature is the use of large heat-absorbing fins on all tubes beyond the fifth row. It is an old story that the first few rows of boiler tubes do most of the work and that later rows hardly earn their keep. Yet little has been done in the way of using less expensive heating surface for this less arduous service. Clearly, fin surface is cheaper than the tube surface it replaces, and the French engineers state that no difficulty is encountered with ash settling between the fins.

Further study may reveal unexected flaws in the design of the Gennevilliers boilers, but the very fact that they depart so sharply from American practice—yet seem to follow along such logical lines—makes them worthy of intensive study.

Reliability of Hydro-Electric Units

HYDRO-ELECTRIC units have, in general, a record for mechanical reliability comparable with that of any other type of power-generating equipment. However, they still offer opportunities for improvement, as is indicated by the report on mechanical reliability of hydro-electric units compiled by the National Electric Light Association's hydraulic-power committee. This committee has been studying the subject for several years, and the report includes a record of two hundred and thirty-five units with an aggregate rating of over six million horsepower.

Although the report is comprehensive and represents a large amount of effort, it is difficult to draw conclusions from the data presented. On the units investigated, the outage has been around four per cent of the total for several years. A study of these records does not indicate definitely whether the reliability of the machines is being improved. If the trend is slightly down one year it may be up the next.

There seems to be a trend toward improvement in the hydraulic reliability of the units. In 1927 waterwheels and their auxiliaries accounted for over sixty-nine per cent of the outage time, whereas in 1929 the outage was slightly over fifty-three per cent. With reaction-type wheels the runner is the vulnerable spot, representing about twenty per cent of the total outage, which is fifty per cent more than is required for inspection and overhauling. This high outage for the runner of reaction-type wheels will probably continue to exist until erosion and corrosion of these parts can be reduced.

On propeller-type wheels the runner gives very little trouble, but the guide bearings and draft tube on the units reported in 1929 accounted for over fifty-two per cent of the total outage. On vertical-shaft francis-type units these parts caused less than seven per cent of the outage. The trouble experienced with the draft-tube and guide bearings of propeller-type units is probably associated with the design of the wheel's setting, and any change that will relieve one will also help the other.

Even though these data do not give all that one would like to know, they do show definite sources of trouble, which knowledge can be made effective in improving design and operation.

Feed Pumps for High Pressures

MULTI-STAGE centrifugal boiler-feed pumps have come into general use for steam pressures below six hundred pounds and have given satisfactory service. This type has also been installed in most of the high-pressure stations employing twelve hundred pounds or more. Their performance in some of these plants has not been as satisfactory as engineers would desire. Some difficulties have been reported with leakage through wearing rings, with end thrust and cavitation at certain water temperatures.

The Benson boilers operating at thirty-two hundred pounds pressure at the Siemens-Schuckert works, Berlin, are supplied by a six-throw plunger-type boiler-feed pump driven by a motor. This pump is said to function satisfactorily under all conditions, but is costly to build, occupies a large amount of floor space and needs considerable maintenance. Naturally, packings of the plungers require much attention. Lubrication needs are more exacting than in a centrifugal pump, and connecting-rod bearings must be adjusted. Air chambers are of little use at high pressures; hence plunger pumps are likely to produce pulsations in the feed piping.

On the other hand, the efficiency of plunger pumps is high, and this may more than offset their higher costs and maintenance. A large plunger boiler-feed pump has been installed in one of the new high-pressure plants in this country. The performance record of this pump will be followed with interest to see whether such difficulties as plunger packings, pipe pulsations and lubrication have been successfully overcome.

In the meantime, one may expect increased study and development of the centrifugal type for high pressures.

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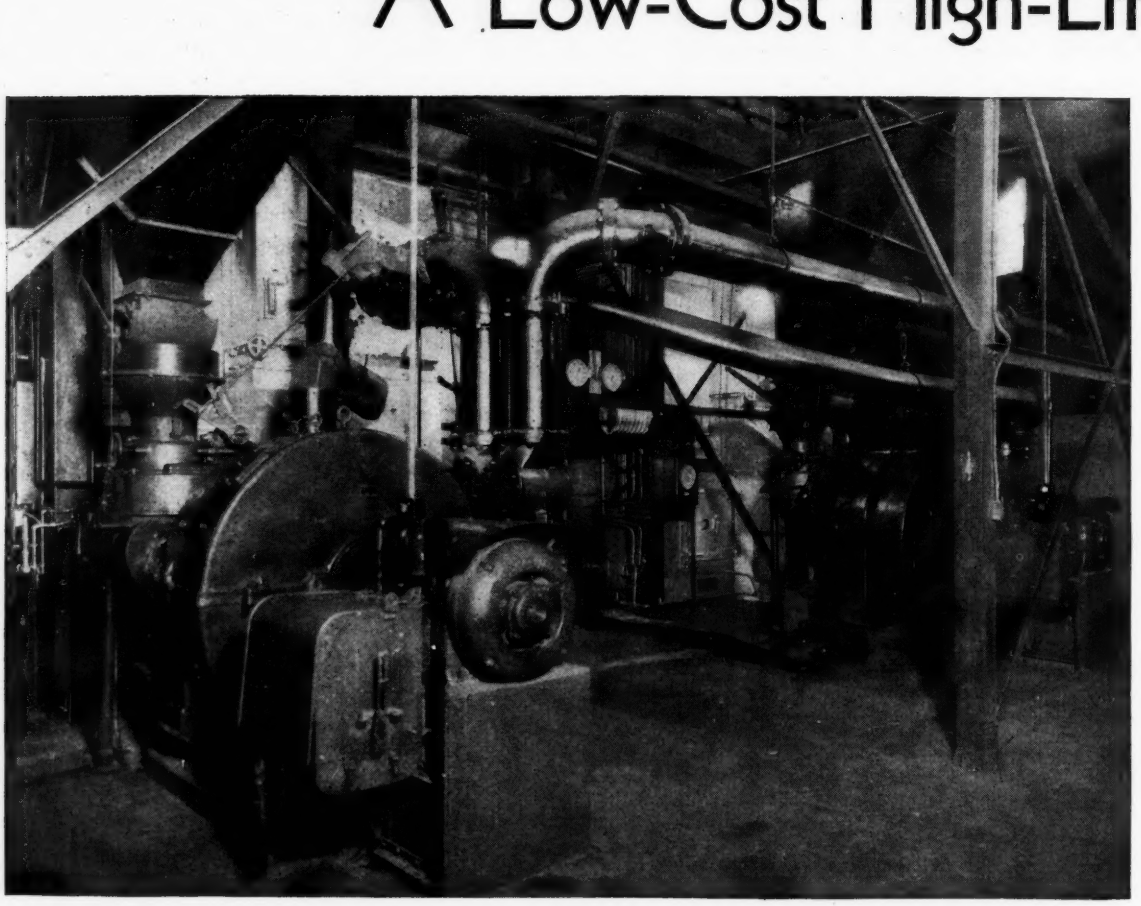
POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

A Low-Cost High-Efficiency In



Unit pulverizers piped to supply either boiler assure Emery Industries, Inc., desired flexibility

AT THE St. Bernard (Ohio) plant of Emery Industries, Inc., the products are stearic acid, red oil, candles and other fatty-acid materials. The process-steam demand is continuous, averaging 36,000 lb. per hour, with occasional three- or four-hour peaks of 48,000 lb. The steam demand fluctuates through a range of 6,000 to 9,000 lb., often as rapidly as 12,000 lb. per minute, but the variation usually is at a rate of 4,500 to 6,000 lb. per minute. Saturated steam at 100 lb. gage pressure is required for process.

The constant changes and development in manufacturing processes and a possibility of the removal of the entire works to a new location for better water supply, dictated a boiler plant having the utmost flexibility and designed with a relation between cost and efficiency such that in event of its abandonment within five or ten years the net loss would be minimum. To reduce the initial cost of the new installation it was decided to utilize the old boiler house building, and it was necessary to maintain steam on the old boilers while the new construction was proceeding.

One interesting expedient to allow placing the first new boiler directly on the location of a brick stack which served the old boilers, consisted in temporarily mounting one of the two new induced-draft fans with its short diffusing stack over the old boiler breeching. The breeching connection to the brick stack was then blanked off and the new connection to the induced-draft fan opened while the old boilers remained in operation. Dismantling of the old brick stack was under way two hours later. When the second new boiler was ready for use, the induced-draft fan was hoisted as a unit, from over the old breeching, into its permanent position.

For the new plant the operating steam pressure is 290 lb. gage, which permits of the most favorable heat balance in conjunction with extraction-type turbine-generators. The turbines will operate with 100 deg. superheat, and external-type steam purifiers will be installed ahead of the superheaters.

All boiler auxiliaries are electrically driven. Normally, current for operation of the motors is drawn from a 250-kva. single-storage turbine-generator, exhausting at 100 lb. pressure into the process steam mains. An alternate source is provided now by the public utility, but in the future will be supplied by the main turbine-generators. In view of the low cost of the small turbine-generator (under $7,000 installed) the plan of driving all auxiliaries electrically proved considerably lower in first cost than had individual turbines been used on half of the boiler auxiliaries.

Raw feed water of 27 grains hardness is treated and reduced to 1½ grains hardness in a hot-process lime-soda system. Mono-sodium phosphate as a secondary treatment is automatically proportioned and introduced into the feed water at the feed-pump suction. This system has given excellent results to date. No difficulty is experienced in maintaining a sulphate-carbonate ratio of 3 to 1 in the boilers, although, owing to the high ratings carried, the total concentrations in the boiler, with 4 per cent blowdown, have been found as high as 600 grains per gallon. Even with such concentrations there has been no evidence of priming when operating at 300 per

Industrial Boiler Plant

Many industrial executives and plant engineers think that the modern high-efficiency boiler plant is expensive and justified only for large loads. In this article the author describes an installation designed for a moderate load costing no more than an ordinary well-built plant

By A. M. KINNEY

Of Kinney & Ehlers, Inc., Consulting Engineers, Cincinnati

cent rating. No trouble has been had with scale deposits in the boiler-feed lines from the action of the sodium phosphate, but close control of the entire softening process is maintained and feed-water samples are analyzed every four hours.

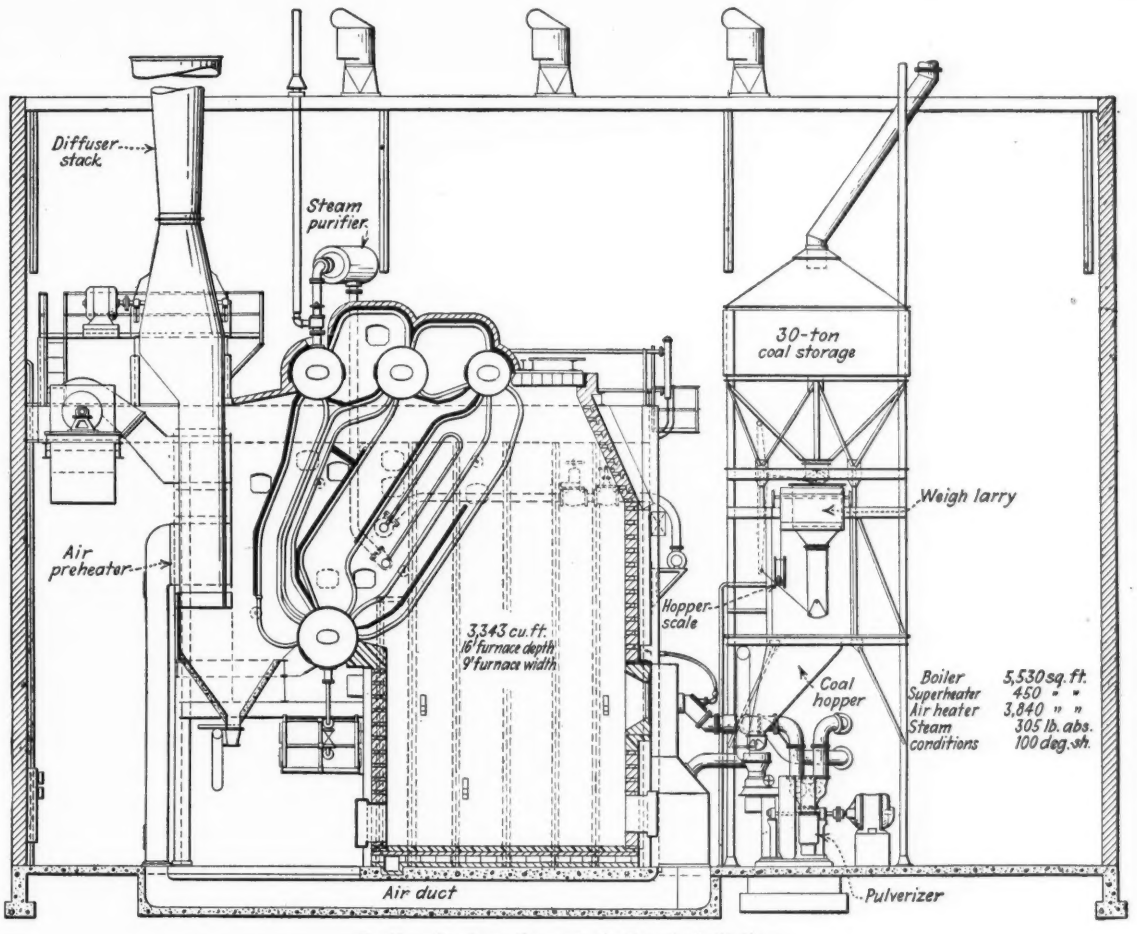
At intervals of from two to three weeks ashes are removed from the furnaces. From 14 to 15 tons accumulate for every 6 to 7 million pounds of steam produced, depending on the coal burned. No fly ash separators are used, as fly-ash discharge is not objectionable in the district where the plant is situated.

A vacuum pipe conveyor system was installed to handle the furnace ashes dry. A suction box, flexibly connected to the system, is carried into the furnace through a rear door. A man in the furnace shovels ashes into the suction box, and no attempt is made to withdraw them while in operation.

Acceptance tests showed a combined boiler and furnace efficiency slightly in excess of 86 per cent. Average results over a period of several months show 84 per cent.

At Emery Industries, Inc., pulverized-fuel firing was selected for the following reasons:

1. Cross-connections in coal piping between pulverizers and boilers assured the desired flexibility. Thus in case



Sectional view through boiler installation

of trouble with either a boiler or a pulverizer, as these units are independent of each other, more of the total equipment is available for use than with a two-boiler stoker-fired plant. The value of this feature already has been demonstrated in the Emery Industries' installation on the occasion of a break in a pulverizer feeder drive chain. The broken machine was shut down and the other pulverizer started and connected to the hot boiler in time to prevent a steam pressure drop of more than 30 lb.

2. The elevation of the boiler room floor with respect to a neighboring stream was such that the pit construction required with stokers was undesirable. The simple flat floor furnace construction used offered many advantages.

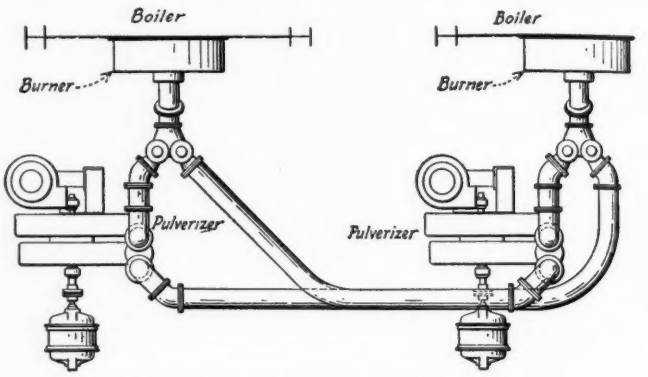
3. For the higher ratings at which it was planned to operate (250 to 300 per cent) it was decided that air-cooled furnace walls would be satisfactory with pulverized fuel, whereas a combination of water walls and air-cooled walls would have been required for equal results with stokers. Although the costs of both types of furnaces were practically equal, the greater simplicity of the full air-cooled job strongly favored its use. Results of actual operation indicate that the air-cooled construction could be omitted in the rear wall of the furnace and could be started 6 ft. above the floor on the other three walls. On wider furnaces the air-cooled walls should be carried closer to the floor for best results.

4. Because some of the coal used in this plant has ash of low fusion temperature, the amount of air preheat which it was deemed practical to use with stokers was limited. With the pulverized fuel installation both the primary and secondary air are preheated to 450 deg. F. This air is drawn by the forced-draft fans from the furnace-wall cooling surfaces at 150 to 200 deg. F. and is then forced through the air heater to secure the higher temperature.

Much thought was given to this feature of the plant design. By referring to the cross-sectional elevation it will be seen that the arrangement lends itself well to a simple and inexpensive system of air ducts. No insulation is necessary where the duct passes under the hot furnace floor. The boiler gases leave the preheater at approximately 325 deg. F., which is as close to the dew point at is was considered advisable to go.

5. As it is necessary to remove ashes from the boiler furnaces only every two or three weeks, the operating labor cost for the pulverized-fuel plant was estimated to be lower than for a stoker-fired plant, where an extra man for handling ashes would have been required on at least one shift every day. Two men on each shift handle the entire plant. When ashes are cleaned the work is done on Sunday. Two laborers, employed elsewhere in the factory during the week days, are able to clean the furnaces in four hours.

To secure higher average year around efficiency the plant has been equipped with full automatic combustion control. While the performance of the equipment fulfilled all guarantees made for it by the manufacturer, the original apparatus did not compensate for the lag in the coal feed through the pulverizer. This lag is an inherent feature of unit pulverizers and varies widely for different makes. For a highly fluctuating load it is essential that this lag be as little as possible As measured at Emery Industries, it is not more than 30 sec.; but with a highly fluctuating load the CO_2 chart shows clearly the effect of even that lag.



Pulverizers and burners cross connected

Experiments with a hydraulic device controlling the air damper in synchronism with the coal delivered to the burner, rather than in synchronism with the pulverizer feeder action, have been successful in producing a steady CO_2. This experimental device was designed by one of the firemen.

In determining the design of an industrial power plant, as much, and often more, consideration should be given to ways and means for reducing the steam and electric requirements of the factory processes. Too often the management looks only to the possibilities of improvements within the confines of the power plant walls and thereupon decides whether it is more profitable to purchase or to generate current, to run the old plant or to install modern equipment.

At Emery Industries, Inc., steam ejector condenser apparatus is being installed to create the vacuum required on a number of stills which at present are handled by means of large motor-driven pumps. Also, the final development of the new plans will include a 100-ton absorption refrigeration machine using steam at low pressure. This machine will replace seven motor-driven compression units. The two changes just described will reduce the total electric load about 85 per cent.

The company is now purchasing $25,000 worth of power each year, but when the new plants are completed this bill will be eliminated. The refrigeration load will be handled with exhaust steam from turbine-generators carrying the station load plus a small factory load. In spite of these gains the total steam load will be less than formerly. And this is not an unusual example of the savings which a careful analysis will show to be possible in many industrial plants.

MECHANICAL EQUIPMENT

Boilers, 2, Stirling, 5,530 sq.ft., 275 lb. pressure — Babcock & Wilcox Co.
Superheaters, convection, 100 deg. F. — Babcock & Wilcox Co.
Air preheaters, plate type, 3,840 sq.ft. — Prat-Daniel Corp.
Furnace walls, steel-suspended air-cooled, with insulated steel casings — Bigelow-Liptak Corp.
Furnace floor, air-cooled — Bigelow-Liptak Corp.
Brickwork — McCabe Construction Co.
Coal pulverizers, No. 4 Atrita — Riley Stoker Corp.
Induced-draft fans and diffuser stacks, Thermix, 1,150 r.p.m. — Prat-Daniel Corp.
Forced-draft fans, 1,755 r.p.m. — Buffalo Forge Co.
Combustion-control equipment — A. W. Cash Co.
Coal conveyors — Weller Mfg. Co.
Coal bunker, 500-ton concrete silo — Circular Concrete Container Corp.
Fabricated piping — National Valve & Mfg. Co.
Valves — Wm. Powell Co.
General piping work — Geerin Bros. & Co.
Boiler feed pumps, 4-stage, 3,450 r.p.m. — Goulds Pumps, Inc.
Water-treating plant, hot-process lime-soda system, 8,000 g.p.h. capacity, with sodium-phosphate treatment — Cochrane Corp.
Motors — Crocker-Wheeler Co.
Turbine-generators — Westinghouse Electric & Mfg. Co.
Switchboards — Westinghouse Electric & Mfg. Co.

Phosphate Deposits Eliminated By Quick Feed

By A. B. STICKNEY
Engineer
Fred Ophuls and Associates

At the Anheuser-Busch power plant phosphates solved the problem of boiler cleaning but caused deposits in feed lines and heaters. This trouble was eliminated by feeding the phosphate very rapidly at intervals of an hour or more

IN THE new Anheuser-Busch power plant, described in the June 17, 1930, number of *Power*, the treatment of boiler-feed water with phosphate, while keeping the boiler surfaces completely free of scale, introduced the problem of soft scale deposit in lines and heaters. A series of changes of phosphate feed methods, extending over a year and each representing an improvement, finally yielded a method which leaves no deposit whatever. The crux of the solution is the rapid feed of concentrated phosphate in batches at relatively long intervals.

Due to process uses of steam, Anheuser-Busch requires 70 per cent make-up, containing 12 to 14 gr. per gallon of total solids, which, in 450-lb. boilers, with extensive water-walls, and water capacity representing but 35 min. full-load steaming, accentuates the importance of the control of both treatment and blowdown.

Treated Mississippi Water

The water comes to the boiler house from the company's own water-works, which treats and distributes some five to six million gallons of Mississippi River water per day. The treatment includes settling, cold-process lime and alum treatment, and chlorination. The resulting water contains, on the average, 2 gr. per gallon of temporary hardness and 8 gr. per gallon total hardness, as well as varying quantities of sodium salts.

Hot Lime-Soda System Plus Phosphate

In the boiler house the water is treated by the lime-soda hot process system, supplemented by the Hall System of phosphate treatment. The first consists of throwing down the temporary hardness by the addition of lime and the substitution of sodium for calcium and magnesium in the "permanent-hardness" salts. This process is carried out at or near the boiling point. The water is filtered, and deaërated by being raised to its boiling point. Calcium carbonate being slightly soluble, some calcium, which is the chief scale-forming radical, is left in solution. The quantity is inversely proportional to the excess of sodium carbonate carried, which excess, in turn, is undesirable, since it increases the total solids and the alkalinity.

The phosphate treatment removes this last remaining calcium as a scale-forming radical by precipitating it in the boiler in the form of a calcium phosphate sludge, in which form it is harmless, except in so far as it increases the suspended matter. The method consists simply of carrying a considerable controlled concentration of phosphate in the boiler. As the calcium-bearing water enters the drum and mixes with the phosphate-laden water, calcium phosphate is precipitated until the product of phosphate and calcium concentrations equals the calcium-phosphate solubility product. Since this is low, and the phosphate concentration is high, the calcium-ion concentration is reduced to practically nothing. A supplementary advantage of phosphate feed is that by using the acid phosphates boiler alkalinities can be carried as low as desired.

At Anheuser-Busch boiler conditions were excellent from the start. After 4,000 hours' operation, the bare-metal inside boiler tubes and headers could be exposed instantaneously by a moderate water jet. The difficulties in application of the phosphate treatment are in feeding. Phosphate does its work in the boiler drum, and may be fed either directly or through the feed water. An excellent system of direct feed, installed in the Kips Bay station of the New York Steam Corporation was described by A. A. Markson in his A.S.M.E. paper of February, 1930[1]. However, it is probably too elaborate for an industrial plant such as Anheuser-Busch.

Trouble With Feed-Line Deposits

When the plant was started mono-sodium phosphate was fed continuously to the deaërator in amounts proportional to the lime-soda-ash feed. This coated the lines, meters, pumps and valves rapidly, and built up in the bleeder heaters so fast that in a week's operation the feed water temperature was cut from 350 deg. F. to 250 deg. F. This was followed successively by the addition of tannic acid; the substitution of Hagan Phosphate (a molecularly dehydrated phosphate developed by the Hall Laboratories to cut down feed-line deposits); the intermittent feed of Hagan Phosphate into the deaërator, where dilution to zero took about twenty minutes every four hours; and, finally, the present system of very rapid intermittent feed into the pump suction. Each step represented a distinct improvement, but not until the final step were completely satisfactory results obtained.

Rapid Intermittent Feed Eliminates Deposits

The system now in use is to feed a given weight of concentrated mono-sodium phosphate into the boiler-feed pump suction every time a certain quantity of water, as shown by the lime-soda proportioner, is fed. In this case a batch of 9 or 10 lb. of phosphate is fed to every 30,000 gal. of water, and it is fed in about 20 sec., on an average of every 1½ hr. By feeding often enough, the probability of unequal feeds through the feed valves building up greatly unequal phosphate concentrations within the boiler is so far reduced as to be negligible. With two boilers operating, the phosphate concentrations in the boilers, which are of the order of 10 gr. per gallon, never get out of step more than 1 gr. per gallon The present feed allows the phosphate to come in contact with very little calcium before entering the boiler, and even this is rendered soluble by being in an acid solution, due to the high momentary concentration of acid phosphate.

With such a treating system, control can be simplified to a minimum. However, careful supervision must be maintained by competent talent, ready to step in immediately in case things go wrong. Specifically, the simplified control is as follows:

LIME FEED is varied to maintain a treated water hydrate alkalinity of 0.2 to 0.5 gr. per gallon.

SODA-ASH FEED is varied to maintain boiler water hydrate alkalinity of 10 to 15 gr. per gallon.

PHOSPHATE FEED is varied to maintain a boiler-water phosphate concentration of 10 to 15 gr. per gallon in each boiler.

BLOWDOWN is varied to maintain a boiler water total solids concentration of 150 to 170 gr. per gallon.

[1] *Power* abstract.

Building Heating With Refrigeration Equipment

THE NEW office building of the Southern California Edison Company, Ltd., claims the distinction of being the first all electrically operated building of its kind. In addition to resistance-type electric heating units, winter heating of the building has been provided for by special arrangement of the refrigerating plant, which in summer is used for air-conditioning purposes. Fig. 1 shows, diagrammatically, a simple refrigerating system. It consists of four principal elements: compressor, expansion valve, cooler and condenser. Operation is quite simple: the liquid refrigerant on the low side of the expansion valve is at a pressure of, say, 24 lb. and temperature of 36 deg. In passing through the cooler it absorbs heat from the water circulating around tubes of the cooler and is converted into

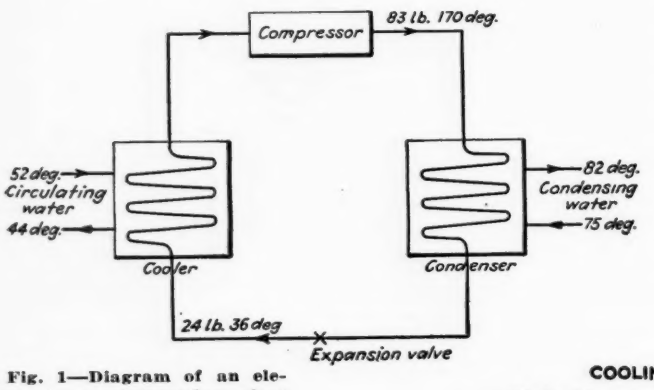


Fig. 1—Diagram of an elementary refrigerating plant

vapor, reducing the temperature of the circulating water from 52 to 44 deg. The vapor is passed through the compressor and is raised to a pressure of 83 lb. and a temperature of 170 deg. This high-temperature vapor is then passed through the condenser and heat is removed from it by the circulating water, thereby condensing it to a liquid. In this operation the condensing water is raised from 75 to 82 degrees.

It is now seen that this elementary system may be used for heating or cooling. For example, the circulating water to the cooler has its temperature lowered and can be used for cooling, while the circulating water to the condenser has its temperature raised and it can be used for heating. Fundamentally, this is what is done in the new office building of the Southern California Edison Company. The cooled water from the cooler is used to cool the building in summer and the warm water from the condenser is used to heat the building in winter. It is seen that if the system is to be used successfully for heating purposes, some source of heat must be available. In the example cited a source of water at 52 deg. temperature must be available to supply the heat absorbed in the cooler and transferred at higher temperature by the refrigerant to the circulating water in the condenser. The Edison Building installation will use the atmosphere as heat source for refrigerating heating.

Forced-draft cooling towers on the roof of the building cool the condenser water in summer. By means of suitable valves and piping the water from the coolers is circulated through these cooling towers to absorb heat from the outside air in winter. Naturally, the water from the coolers must at all times be lower than the wet-bulb temperature of the atmosphere to absorb heat. Also, the cooler water must always be kept above the freezing point, as it was not considered desirable or necessary to circulate brine instead of water through the coolers to operate at a lower temperature. These two conditions, therefore, fixed the temperature limits for the cooler water, which will enter the cooling tower

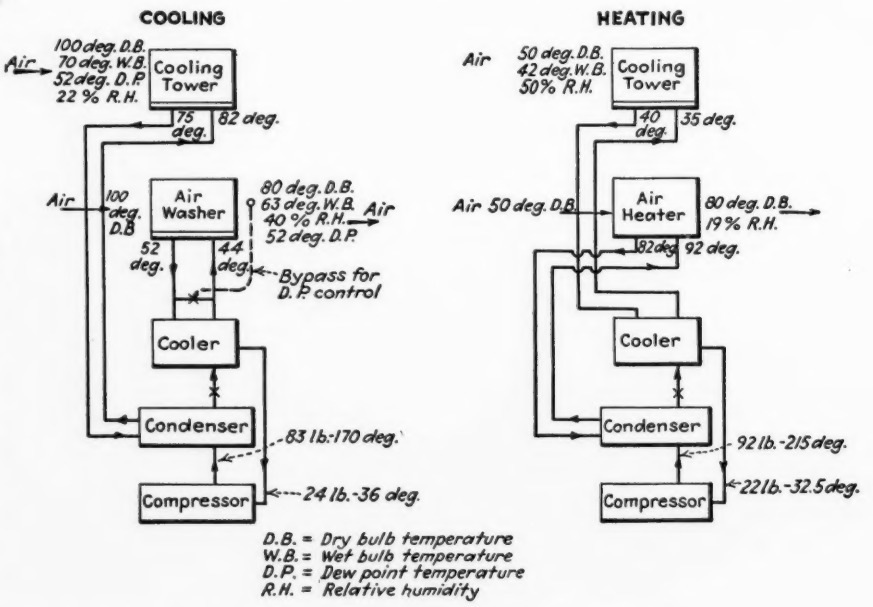


Fig. 2—Diagram of refrigerating system showing arrangement used for cooling and heating Edison office building

at 35 deg. and will be heated to 40 deg. on the basis of a minimum outdoor wet-bulb temperature of 42 deg. Should the outdoor wet-bulb temperature be lower than 42 deg. the equipment will not be used for heating.

In the cooling system the condenser water is circulated through the cooling tower, having its temperature lowered from 82 to 75 deg. and the water from the cooler is circulated through an air washer, thereby lowering the temperature of the air going into the building for the dual purpose of cooling and humidity control. In the heating system the condenser water is circulated through a tubular air heater, having its temperature lowered from 92 to 82 deg. and heating the air supplied to the building to 80 deg. The water from the cooler is circulated through the cooling tower, having its temperature raised from 35 to 40 deg., thereby absorbing heat from the outside air. The diagrams of Fig. 2 show that under the heating condition the refrigerant is at a higher pressure than under the cooling condition. This is necessary in order that the temperature of the condenser water will be high enough to heat the air to the building to 80 degrees.

Perhaps the most astonishing thing about this system is its apparent high efficiency, as it is theoretically possible to absorb and discharge into a building ten or more times the heat equivalent of the power required to operate the equipment. It is not possible to attain this result in practice, due to the fact that power for operating pumps, in addition to the refrigerating compressor, will be required; also the efficiency of the cycle does not closely approach the theoretical.

In the Edison Building it has been estimated that the expenditure of 510 kw.-hr. in power will be required for the absorption and transmission to the building of 1,100 kw.-hr. in heat. This is on the basis of an outdoor wet bulb temperature of 42 deg., which occurs at rare intervals. The more closely the lower temperature can approach the higher temperature the greater the efficiency, and it is, therefore, believed that under average conditions the actual system in the Edison Building will transmit to the building practically three times the equivalent of the power input to the equipment.

Power is indebted to H. L. Doolittle, chief engineer, Southern California Edison Co., for this information.

▼ ▼ ▼

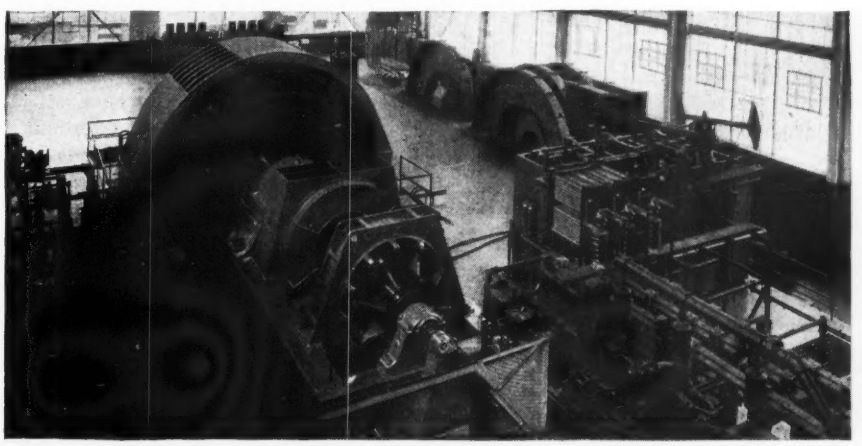
Testing Laboratory Has 100,000-Kva. Capacity

THE ADDITION of a 60,000-kva. generator gives the Westinghouse high-power testing laboratory at East Pittsburgh, Pa., a capacity of 100,000 kva. for testing circuit breakers and other switching equipment. Tests made with the original 40,000-kva. generating equipment have resulted in many advances in circuit-interrupting devices for electric power systems. The increase of capacity to 100,000 kva. makes possible further fundamental improvements in circuit breakers and other apparatus for controlling the vast power concentrations which are becoming general throughout the country.

In ordinary generators, short-circuits are destructive accidents to be avoided, but to these test machines they are merely routine duty. At such times the power they develop momentarily is tremendous. It may reach 1,000,000 kva. on symmetrical 3-phase, 60-cycle short circuits, and 70 per cent more on assymetrical short circuits. With special test arrangements the equivalent of 3,000,000 kva. may be supplied. The installed capacity of all the generating stations at Niagara is less than 1,500,000 kilovolt-amperes.

Special construction was necessary for testing service, particularly the bracing of the coils and windings, without which these parts would be torn from their positions by the tremendous short-circuit forces. An idea of the size of this new machine is indicated by the weight of the rotor, 275 tons. When up to speed it would require two hours for the machine to coast to rest were it not stopped by electrical braking. The new generator, like the one before it, is built with about 10 per cent reactance.

Unusual attention has been given to safety features in the operation of this machine. Sixteen photo-electric cells strategically located around the generator room have their electric eyes constantly on it and will detect a flashover and open all circuits quicker than the human eye can detect a fault. In addition, an observer is constantly on duty in a special steel and heavy-glass cell to overlook the equipment and bring the machine to a stop in case of trouble. Equipment to be tested by this machine is placed in reinforced cells at the rear of the laboratory building. All tests are controlled from a safely remote point.



A 60,000-kva. generator of special construction for testing high-capacity circuit breakers and other switching equipment

MERCURY-ARC POWER RECTIFIERS:

Their Construction and Operation

Fig. 1—Mercury-arc power rectifier rated at 600-volts 3,000 amp. direct current

MERCURY-ARC power rectifiers have in a few years been developed to where they are now a keen competitor of rotary converters and motor-generator sets. They have been built in size up to 6,000 kw., for voltages up to 3,000 and to supply all kinds of direct-current loads. In this article the construction and operation of this equipment is considered; a second story will deal with industrial applications

By W. E. GUTZWILLER
Rectifier Engineer
American Brown Boveri Co., Inc.

MERCURY-ARC rectifiers were developed as a substitute for rotating converters for changing alternating to direct current. They are an outgrowth of the glass-bulb rectifier which came into use about twenty-five years ago. A great deal of commercial development work on the mercury-arc rectifier has been done by the engineers of the Brown Boveri Company, Switzerland. Within the last few years mercury-arc rectifiers have successfully entered practically all fields of power conversion. There are today approximately 1,800,000 kw. of mercury-arc rectifiers installed and on order throughout the world, of which approximately 600,000 kw. is used for direct-current light and power in industrial applications.

A mercury-arc rectifier's operation depends upon the valve action of a metallic arc burning between two electrodes in a high vacuum. Current can pass only if the negative electrode (cathode) is excited, that is, made white hot by electronic emission, and if the other electrode (anode) is maintained at a temperature at which no electrons are liberated. It is therefore essential that suitable electrodes are used, so that only one is excited, and that the vaporized electrode material is automatically returned. Mercury is used in commercial rectifiers, since it can easily be condensed and returned to the cathode. For practical reasons, rectifiers are provided with a suitable number of anodes, of which each is connected to a secondary phase of the rectifier transformer. Each anode carries current only during that part of the cycle when its voltage is higher than that of the others. The cathode carries current all the time.

Fig. 2 shows the general design of a large modern mercury-arc power rectifier. The main parts of the rectifier are the mercury cathode, the anodes, the arc chamber and the condensing chamber. On the bottom of the arc chamber is the insulated mercury cathode. The top of this chamber is closed by the anode plate. Six twelve, eighteen or twenty-four main anodes are placed in a circle around the anode plate. There are two auxiliary, or excitation, anodes which maintain the rectifier in operating condition through a single-phase alternating-current source, independently of the load on the main anodes. Above the center of the anode plate is the condensing chamber. This is closed by a coverplate carrying the ignition device and the vacuum pump connection. The upper portion of the rectifier, consisting of the condensing dome and anode plate, can be removed from the arc chamber for inspection and repair of the rectifier. The arcing chamber and the condensing dome are surrounded by a sheet-metal water jacket. Cathode and anode plates are also water-cooled. The cooling water enters at the cathode and leaves at the top of the condensing dome.

For high direct-current voltages the anodes are equipped with air-cooled fin-type radiators as shown on the left-hand anode. To obtain more efficient cooling of the anodes, such as required for high current ratings

corresponding to medium and low direct-current voltages, the anodes are water-cooled by an inclosed thermo-syphonic system. A water-cooled anode of this type is shown on the right-hand side of the rectifier in Fig. 2.

The anodes are insulated from the casing by porcelain, and the cathode by porcelain or mica and rubber. The anodes, which are made of steel or carbon, depending on rating and type of service of rectifier, are pressed against the lower surface of the anode insulator by springs. The anode heads are surrounded by a sheet-metal sleeve fastened to a flange on the anode insulator. Connections to the anodes are made to terminals on their upper ends. A funnel-shaped collector is placed above the cathode to guide the rising stream of mercury vapor. The auxiliary, or excitation, anodes are built on the same principle as the main anodes.

The maximum admissible temperature as measured on the anode plate is about 140 deg. F. A contact-making thermometer mounted on the anode plate gives an alarm when a given temperature is exceeded. In case the temperature rises further, the contact-making thermometer disconnects the rectifier from its alternating-current supply.

A high vacuum on the order of 0.01 to 0.001 millimeters of mercury is essential to successful operation of a mercury-arc rectifier. To maintain such a vacuum in the arc chamber it was necessary to develop reliable seals for the electrodes and other removable parts. On all American Brown Boveri rectifiers mercury seals are used. The mercury seal of an anode insulator is shown in Fig. 3. An asbestos ring *C* is placed in the machined recess of anode plate *A* and is compressed by insulator *B*. The mercury *G*, forming the seal, is closed in its chamber by rubber ring *E*, held down by flange *D*. The seal can be filled through mercury gauge *F*. An outstanding feature of the mercury seal is that the slightest leak can be discovered and corrected immediately. A leak in a mercury seal is indicated by the mercury level slowly sinking in the gage. Tightening the press bolts of the leaking seal is all that is required to remedy the fault. Even while leakage exists, only mercury gains access to the arc chamber and does the rectifier no harm.

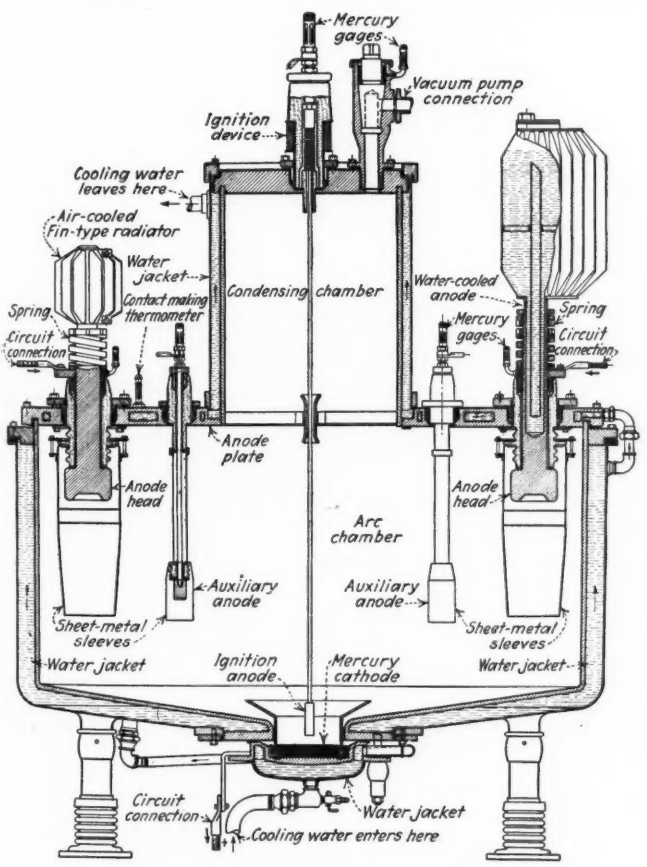


Fig. 2—Cross-section through a large mercury-arc power rectifier

After the rectifier has been assembled in the shop it must be degassed by exhausting air from the cylinder, heating the cylinder and then drawing off the gas thus freed. All rectifiers are completely degassed in the shop before shipment. Because several weeks generally elapse after this operation, a second but shorter degassing which can be done in a few hours is usually necessary before the rectifier is put into service.

To maintain the vacuum in the rectifier a high-vacuum pump set is provided. Fig. 1 shows a 600-volt 3,000-amp. 12-anode rectifier with vacuum pump, the latter being on the right-hand side. The anodes are of the water-cooled type.

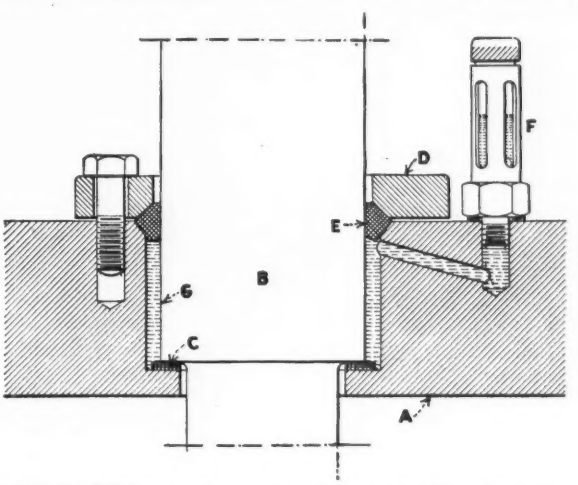


Fig. 3—Mercury seal on an anode insulator. *A*, anode plate; *B*, anode insulator; *C*, asbestos packing ring; *D*, flange; *E*, rubber ring; *F*, mercury gage; *G*, mercury.

The high-vacuum pump can only work when connected in series with a rotary vacuum pump, on account of its low compression ratio. It is equipped with a heater of 500- to 1,000-watt capacity. The pump compresses the gases extracted from the rectifier to a pressure of about 0.5 mm. of mercury. The initial vacuum created by the rotary pump is about 0.04 mm. of mercury. The overlapping of the two characteristics is sufficient to insure stable operation of the pump. The duty of the rotary vacuum pump is to discharge into the atmosphere the mixture of gas and air extracted from the rectifier by the high-vacuum pump. The rotary vacuum pump is sealed by oil, which also serves to lubricate its moving parts and to control the automatic vacuum valve. The rotary vacuum pump is driven by a single- or three-phase motor. The pump set has a large volumetric capacity and can evacuate rectifier cylinders in a short time and thereafter maintain a pressure on the order of 0.001 mm. mercury during service.

An excitation and ignition set, together with the excitation anodes, are provided to prepare and maintain the rectifier in readiness to carry load. The voltage necessary to start an arc under conditions normally obtained in a commercial rectifier is many times greater than the voltage necessary to maintain the arc once it is started. However, when the space between the anodes and the cathode is partially ionized or excited, by the presence of

another arc and cathode spot, the voltage normally applied in commercial rectifiers is sufficient to start the main arc. Two auxiliary anodes on the rectifier provide necessary excitation for the main anodes, but the ignition device is needed to start or ignite the excitation arc.

Fig. 4 shows the connection diagram for the ignition and excitation circuits of a mercury-arc rectifier. As long as excitation transformer T is not energized, the contactors C and C_1 are closed. When the transformer is connected to the auxiliary supply, alternating current flows through ignition coil I, which draws down ignition anode A until contact is made with the mercury of the cathode M; thus current flows through contactors C and C_1. Contactor C, adjusted to operate on a small current, functions immediately and breaks the circuit of ignition coil I. Ignition anode A is drawn up by spring S, striking an arc at the surface of cathode M.

If the polarity of the arc is not correct, excitation anodes E are not ignited. The arc at ignition anode A dies out instantly and relay C releases its armature and the ignition anode is again immersed. This operation is repeated until the polarity of the ignition arc is correct and excitation anodes E are ignited. The excitation current operates contactor C_1, which interrupts the circuit for ignition anode A. If the voltage of excitation transformer T fails, both contactors return to the starting position. With this arrangement rectifiers are ignited within less than one second. The power consumption in the excitation arc is approximately 800 volt-amperes.

The main transformer furnishes 6-phase or 12-phase current at a voltage suitable for the rectifier's operation. The relatively high number of secondary phases is employed in order to better utilize the transformer and to reduce the pulsations in the rectified current to make it suitable for commercial use. Fig. 5 shows a complete diagram of connections for a 6-phase manually operated rectifier unit with interphase transformer connections.

All mercury-arc power rectifiers are water-cooled. Three different types of cooling are in use, depending on the rectifier's direct-current voltage, the quantity of cooling water available, its pressure and quality. The methods are:

(*a*) Direct cooling by tap water.
(*b*) Indirect cooling by tap water.
(*c*) Closed circuit forced-draft cooling.

Direct cooling by tap water is the simplest method. It is used in plants with direct-current voltages up to 1,500 where sufficient cooling water is available and where the water is neither too muddy nor too hard. To insulate the rectifier from ground a rubber hose is inserted in the cooling-water inlet. The cooling water is discharged, usually into an open funnel, and the amount of fresh water required is aproximately $\frac{1}{3}$ g.p.m. at approximately 60 deg. F. for each 100 amp. direct-current.

Indirect tap-water cooling is used where the available water is not suitable. The tap water passes through a tubular-type cooler through which the rectifier cooling water is circulated by means of a pump.

Closed-circuit forced-draft cooling is used where the direct-current voltage of the rectifier is higher than 1,500 volts, thus avoiding any ground connections through the cooling water inlet and discharge pipe. This type of cooling, furthermore, must be considered for installations where fresh-water cooling is expensive or where sufficient water is not available. A diagram of closed-circuit forced-draft cooling equipment is shown in Fig. 6. It consists of a radiator unit through which the rectifier cooling water is circulated by a motor-driven water pump. The radiator unit is cooled by a motor-driven fan. An expansion tank is used to compensate for expansion and contraction of the water due to temperature changes, to compensate for evaporation and to keep the water system primed.

For cooling the high vacuum pump approximately $\frac{1}{3}$ g.p.m. of water at 60 deg. F. is required. It is preferable to have the high-vacuum pump cooled by tap water. In plants where no tap water is available a separate radiator unit and circulating pump mounted on a common frame with rectifier cooler may be provided. In automatic substations with direct or indirect tap-water

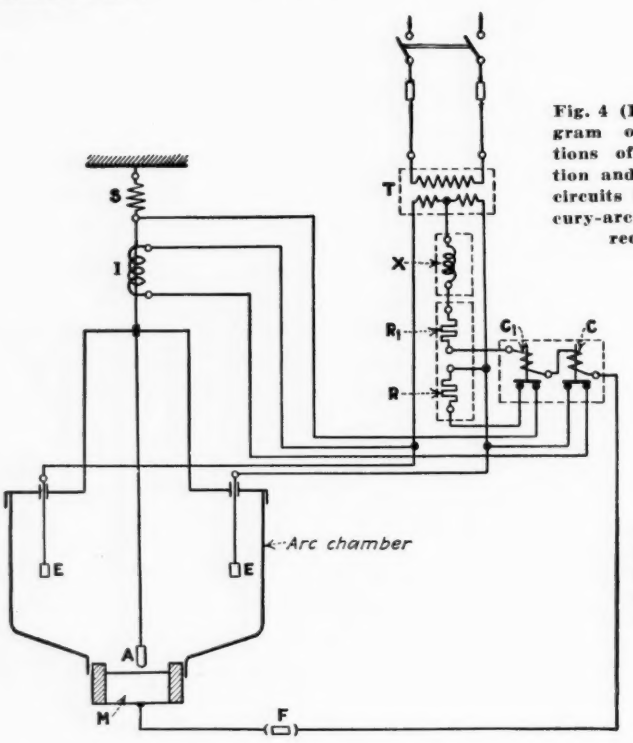


Fig. 4 (Left)—Diagram of connections of the ignition and excitation circuits for a mercury-arc power rectifier

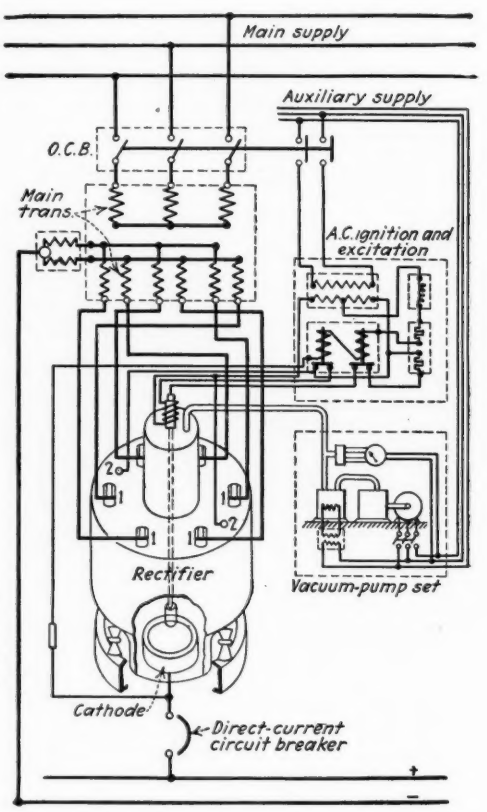


Fig. 5 (Right)—Diagram of connections for a 6-phase manually operated rectifier unit

cooling, the flow is started or stopped by electrically operated valves.

Because of its simplicity in starting, stopping and in operation, the rectifier is inherently suitable for automatic control. The majority of rectifier plants in operation are provided with full automatic remote or supervisory control. Automatic control of a rectifier unit usually consists of automatic control for the vacuum-pump set, control for starting and stopping of rectifier unit and control for operation and protection of the rectifier.

In the rectifier, the total voltage drop which comprises the sum of the voltage drops on the cathode, anode and in the arc is practically constant for a given type of equipment and varies between 19 and 30 volts, according to the size of the unit. It follows from this that the higher the rectifier direct-current voltage the higher is its efficiency. Furthermore, for a given direct-current voltage the rectifier's efficiency is practically constant for all loads. This can be seen from Fig. 7, where curve *A* shows the efficiency of a rectifier as a function of the direct-current voltage. Curve *B* shows the efficiency of a 300-kw., 250-volt rectifier, including the auxiliaries. Where the load fluctuates, as, for instance, in traction or crane service, the capability of the rectifier to operate at partial loads with a high efficiency is of special value.

The power factor of a rectifier set varies between 94 and 91 per cent for the usual transformer connections and is fairly constant over the whole range. There are no means of power-factor adjustment on the rectifier.

Although the voltage drop in a rectifier is practically constant for all loads, a shunt characteristic is obtained from the combination of rectifier and transformer. The percentage of regulation is determined by the reactance of the transformer. It varies between 5 and 6 per cent, according to type of transformer connections. For most purposes natural regulation of the rectifiers is enough. Rectifier transformers are always provided with a suitable number of full-capacity taps on the primary winding

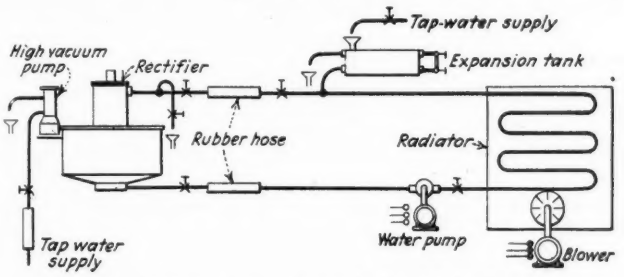


Fig. 6—Diagram of closed-circuit, forced-draft cooling apparatus for mercury-arc rectifier

and with ratio adjusters for no-load operation. By means of these taps, variations in the primary supply voltage can be compensated for, and the direct-current voltage may be adjusted for an average value satisfactory for normal operating conditions.

When the rectifier's direct-current votage is to be adjusted under load—for instance, in order properly to divide or shift load between substations or between rectifiers and converters in the same station—load tap-changing equipment may be provided on the rectifier transformer.

Another method of regulating the direct-current voltage of a mercury-arc rectifier is by controlling the electric field between anodes and cathode. This is obtained by means of insulated metallic grids, inserted in the arc path. By applying a suitable potential to these grids the instant at which the anode starts to work may be delayed, whereby the average direct-current voltage of the rectifier can be reduced.

Rectifier operation is not affected by the frequency of the primary supply system. Where two sources of power at different frequencies are available at a substation the rectifier transformers and auxiliaries may be designed for operation on both frequencies, much greater flexibility in substation operation resulting. Many rectifier substations have been built to operate on 25- and 60-cycle power supply, some of them being fully automatic and changeover from one frequency to the other being carried out instantaneously upon the failure of one of the supply systems.

Substation buildings for rectifiers are of simple design and consequently their costs are low. Rectifiers can be

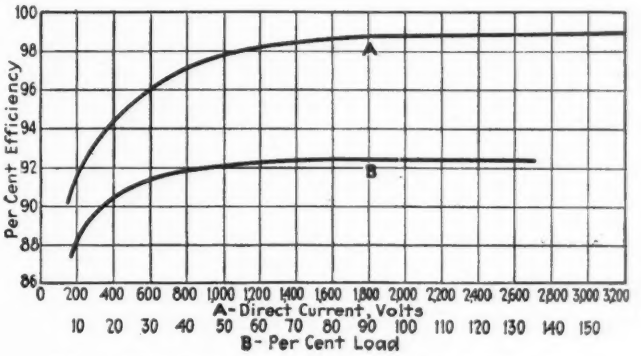


Fig. 7—Efficiency curves of a rectifier, including auxiliaries: *A* for various d.-c. voltages; *B*, a 300-kw., 250-volt rectifier at various loads

located in places which otherwise could not be used for installing converting equipment of the rotating type. Some of these are in localities where the atmosphere is laden with moisture, steam, dust, acid fumes, or in basements of office buildings, apartment houses, hospitals, schools and other places where noise and vibration of a rotary converter or motor-generator set is objectionable.

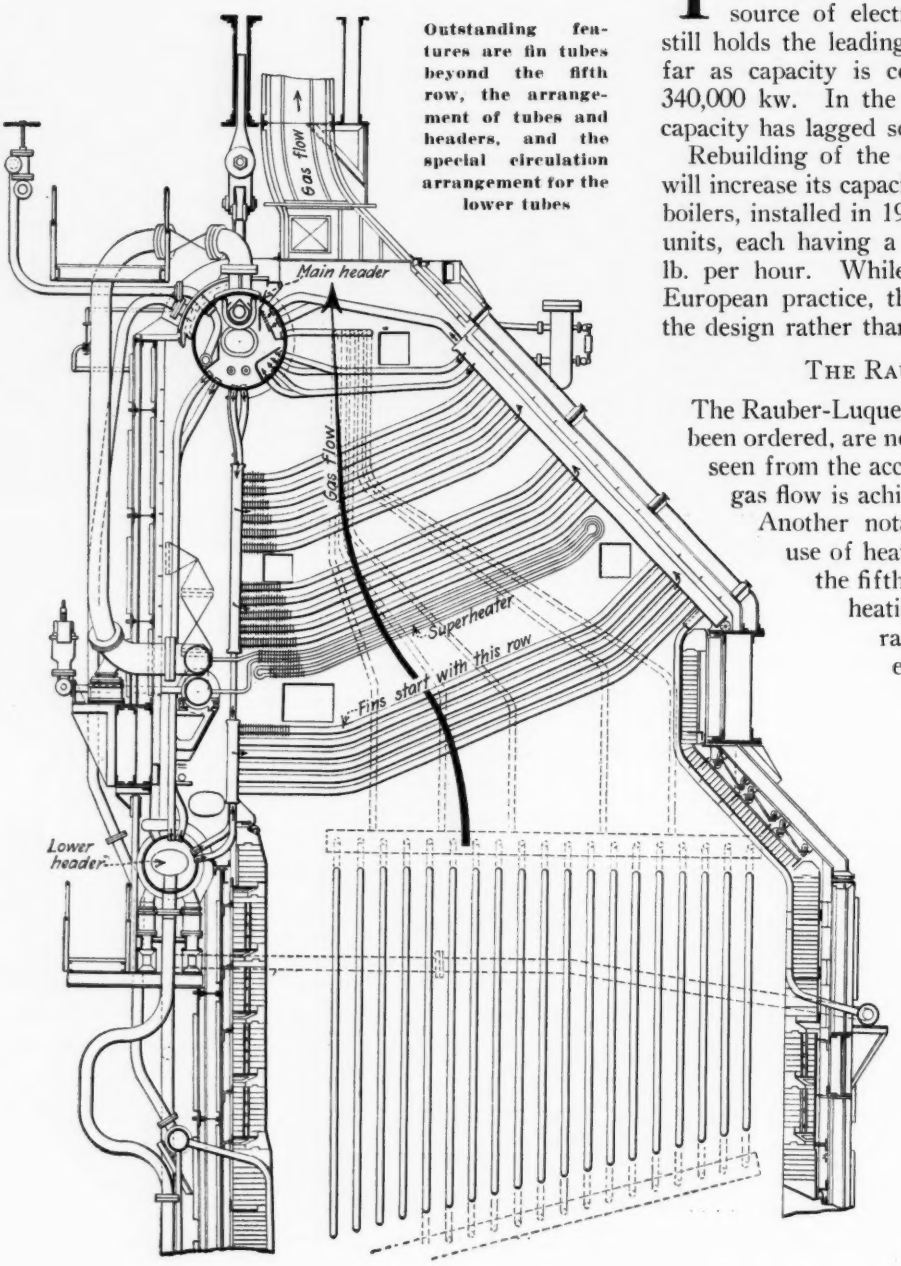
Iron-Nickel Alloy of High Magnetic Properties

HIPERNIK, a refined iron-nickel alloy, is annealed in an atmosphere of hydrogen at a temperature ranging from 1,000 to 1,300 deg. for many hours. This process removes small impurities, chiefly oxygen, said to exist in the ordinary 40 and 60 per cent alloy. According to T. D. Yensen, of the Westinghouse Company, who developed this alloy, impurities in it, even a few hundredths of 1 per cent, produce differences in the magnetic properties of several hundred per cent. Hence the engineers have been seeking a method of removing the last traces of impurities. In Hipernik they have succeeded, according to Mr. Yensen, who asserted that Hipernik is the nearest approach to the ideal magnetic alloy that has been developed. It has high permeability, negligible hysteresis loss, ductility, non-corrosive quality and comparatively low cost of production.

It was discovered that the magnetic properties of iron depend upon the regularity of the arrangement of the atoms in the space lattices. A mere trace of impurities serves as tiny wedges to distort the symmetry and disturb the magnetic properties. It was found that a special hydrogen heat treatment removes the impurities.

GENNEVILLIERS Installs Single-Pass Fin-Tube Boilers

RAUBER-LUQUET UNITS COMBINE COMPACTNESS, GOOD CIRCULATION AND LOW FIRST COST



Outstanding features are fin tubes beyond the fifth row, the arrangement of tubes and headers, and the special circulation arrangement for the lower tubes

THE GREAT Gennevilliers steam-electric station, erected several years ago as the most important source of electrical energy for the city of Paris, still holds the leading position in the French capital, as far as capacity is concerned. Its present capacity is 340,000 kw. In the enlargement of the station, boiler capacity has lagged somewhat behind turbine capacity.

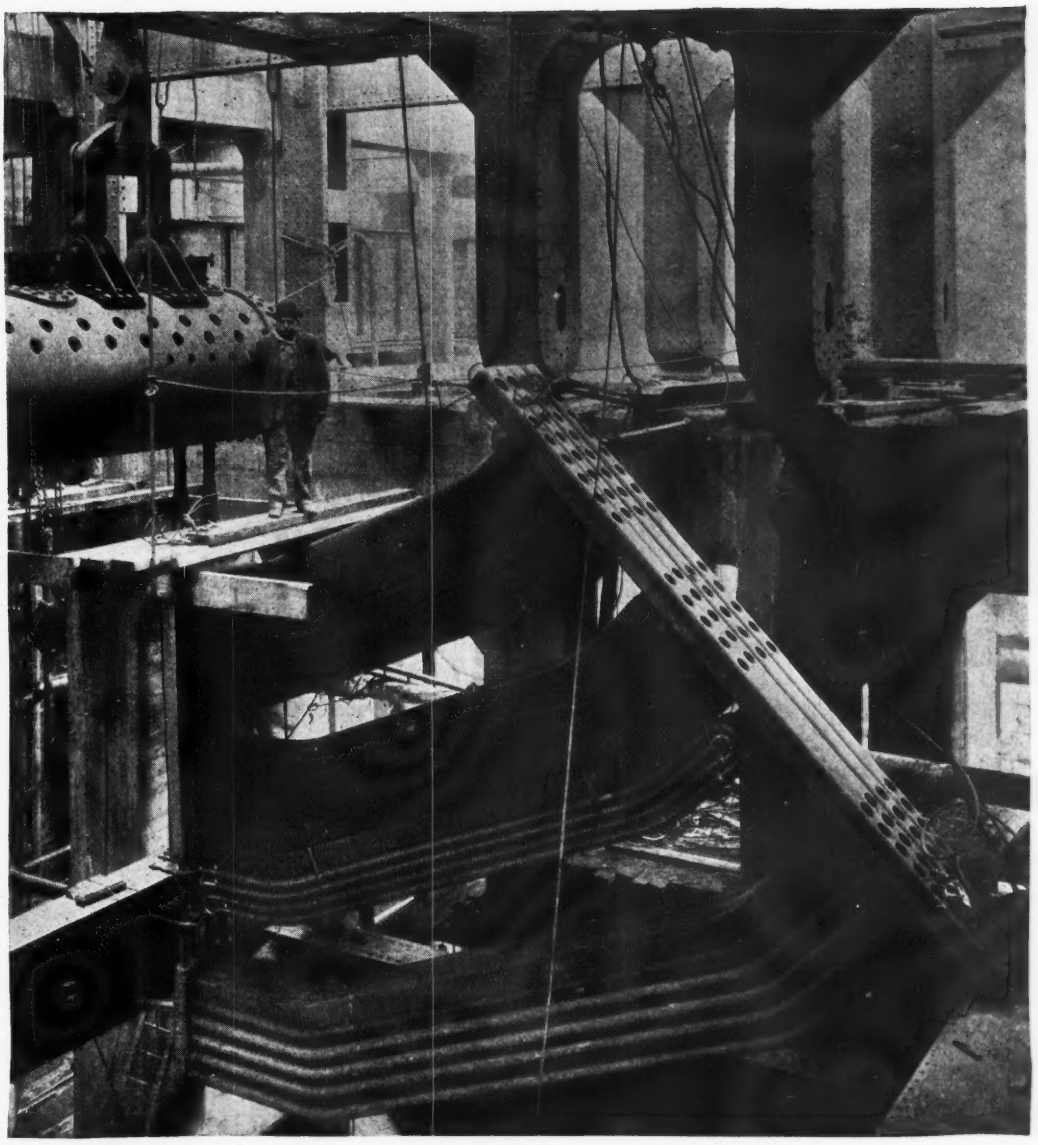
Rebuilding of the old boiler house, now in progress, will increase its capacity 50 per cent. For the 15 original boilers, installed in 1921 and 1922, will be substituted 10 units, each having a capacity from 240,000 to 300,000 lb. per hour. While these boilers are very large for European practice, the feature of particular interest is the design rather than the size.

The Rauber-Luquet Boilers

The Rauber-Luquet boilers, four of which have already been ordered, are notable in several respects. As will be seen from the accompanying illustrations, single-pass gas flow is achieved in a strikingly simple manner. Another notable feature of this boiler is the use of heat-absorbing fins on all tubes beyond the fifth row. This extension of the boiler-heating surface in the regions of less rapid absorption results in great economy of space. The design, it will be noted, lends itself to rapid circulation.

The tube bank is formed of 44 identical sections, each composed of 17 tubes, all but the lower five being provided with fins. At the back of the boiler these tubes enter a straight box-like disengaging header through perpendicular connections.

In front the headers are separated into two sections connected by suspension tubes. All of the lower sections are connected to the lower auxiliary drum. This drum, in turn, is connected to the principal drum. By this arrangement the tubes exposed to radiant heat have excellent circulation.



Four sections of new boiler installed at the Gennevilliers station. Complete boiler will have 11,680 sq.ft. of heating surface without fins, or 31,600 sq.ft. including fins

The upper parts of the vertical headers are all connected to the principal drum, thus assuring circulation in the upper tubes.

Each of the sloping disengaging headers is prolonged at its upper end by a bent tube (4.54 in. outside diameter) which assures release of the steam from the surface of the water. A little above the seventeenth row of boiling tubes are two tubes (3.24 in. outside diameter) connecting each sloping header to the principal drum below the water level, thus completing circulation.

This arrangement insures good release of vapor, combined with extremely active circulation, not only in the tubes exposed to the fire, but in the other tubes of the boiler.

Above the sixth row of tubes is a large space kept free for inspection, cleaning and dismantling of the superheaters. Between the eleventh and twelfth rows of tubes is another space for inspection and cleaning. These two spaces can eventually serve for replacement of upper-bank tubes.

Since the boiler elements are too large for transportation in the completely fabricated form, they are assembled on the job. It is generally possible to assemble and to place two or three elements per day of work. Supplementary data on the R.L. boilers is given in Table I on the next page.

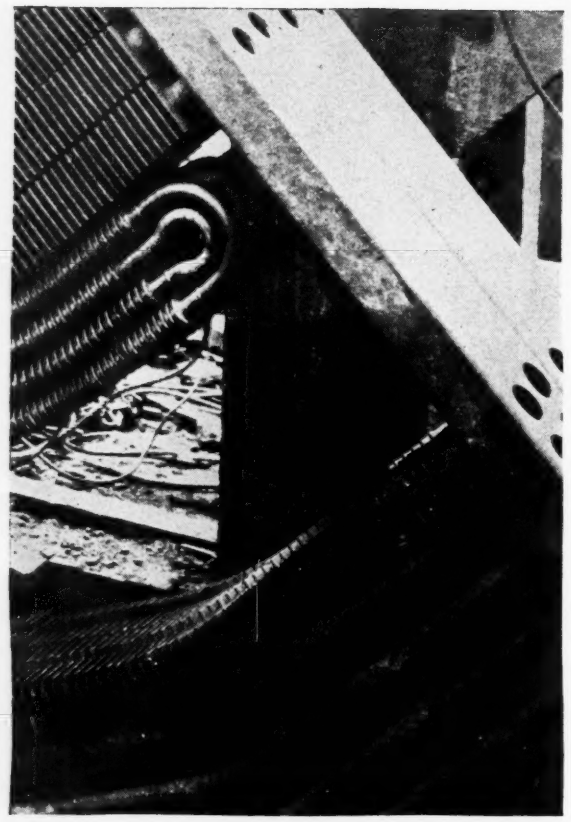
Fins Used on Superheater Tubes

The water wall protective system of four vertical walls of the combustion chamber is partly integral with the boiler. It includes:

1. The side drum wall, 28 tubes 2.88x3.24 inches.
2. The lateral walls, each of 36 tubes 2.88x3.24 inches.
3. The front wall (corresponding to the 45-deg. parts), 44 tubes 2.88x3.24 inches.

This system requires, of course, horizontal headers for the supply of feed water and for the release of the steam.

The superheater is placed between the sixth and seventh bank of boiler tubes. It is hung from the



Close-up view of portion of sections shown on preceding page

seventh row by strong welded straps. The total exterior tubular surface of the superheater is 2,580 sq.ft. The fin surface is 5,640 sq.ft. The fins are spaced 1.18 in. on the two hot turns, and 0.98 in. on the two cold turns.

The superheater consists of 86 tubes (1.32x1.66 in.) in parallel, all with fins, the tubes having the general form of the boiler tube bank and following their course. Each tube has four sections, of which the average length is about 16 ft. The superheater tubes pass between the vertical connecting tubes of the vertical header, and come together in two horizontal headers placed one above the other. Conical-connecting joints are used.

To assure the proper position of the different bends, each bend of the tube is connected to its neighbor by a strap of sheet iron so welded to the fin as to permit of movement in one direction.

The new Vitry Sud station of l'Union d'Electricite is taking away much of the base load from the Gennevilliers station. For that reason, first cost is carefully considered in selecting equipment for the revamped boiler room. As a result of this consideration pulverized coal was rejected and underfeed stokers installed.

Boilers Are Stoker-Fired

Two of the new boilers will be fired on one side by 16-retort, 57-tuyère Taylor stokers. The other two will be fired by Ratel underfeed stokers. The walls of the Taylor-fired stokers will be protected by water-cooled cast-iron blocks such as are used in the United States.

TABLE I—SUPPLEMENTARY DATA ON R. L. BOILERS

Pressure, lb. gage	425
Water-heating surface, without fins, sq.ft	11,680
Water-heating surface, with fins, sq.ft	31,600
Size of smooth tubes, in	3.27 x 3.70
Size of fin tubes, in	2.91 x 3.24
Thickness of fins, in	0.20
Width of fins (square), in	6.6
Spacing of the fins, in	0.98 to 1.38

Two clinker grinders will be installed. The Ratel-fired furnaces will likewise have two clinker grinders, but cooling will be by air-cooled cast-iron blocks.

No air heaters will be installed. Each boiler will have a steel tube economizer. To provide an interesting comparison, one of the economizers will have steel tubes with welded fins.

While these are the largest R.L. boilers yet constructed, this design is not entirely new. Three years of experience with boilers of this type have indicated to the Gennevilliers authorities that the ash has a very small tendency to adhere to the transverse fins, that the resistance to the passage of gas is small and that the advantage gained by the change is almost equal to that theoretically shown.

With water at 185 deg. F. at the entrance to the economizer, the operating conditions are as follows:

Steam output, lb. per hr	132,000	238,000	298,000
Temperature of gas leaving boiler, deg. F	527	622	673
Temperature of gas leaving economizer, deg. F	266	320	338
Gas resistance, inches of water	0.08	0.36	0.6
Guaranteed efficiency, per cent	87	84	83

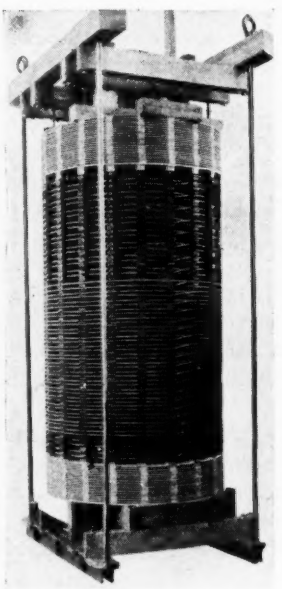
It is believed that these efficiencies will be surpassed by several points. The two first R.L. boilers of Gennevilliers will go into service in September or October, 1931.

Three of the boilers ordered will be furnished by the French Babcock & Wilcox Company, and the fourth by the Société Als-Thom, Belfort.

This article is based on information, drawings and photographs furnished through the courtesy of G. Darrieus, Secretary General, Cie. Electro-Mechanique, Paris.

Oil-Immersed Current-Limiting Reactors of Record Size

Three oil-immersed, current-limiting reactors, each of which is almost twice as large as any predecessor, were recently built for installation in the Newark substation, at the south end of San Francisco Bay, of the Pacific Gas & Electric Company by the Westinghouse Electric & Manufacturing Company. These reactors, each of which is rated at 5,400-kva., 300 amp., will be used to reduce short-circuit current between two 110,000-volt buses to 3.5 times normal rated value. Each reactor consists of an air-core coil immersed in a tank of oil protected by Inertaire (nitrogen gas) equipment. A laminated-iron magnetic shield protects the tank wall from stray losses due to the strong magnet field.



The complete reactor is 8 ft. in diameter, 22 ft. high and weighs more than 36 tons. The outside diameter of the coil is 52 in. and its height, including disk washers, is 96 inches.

Insulation Specifications and Economical Thickness

By E. F. ZEINER
Philip Carey Company

PRECEDING ARTICLES in this series have omitted reference to the economical combinations and thicknesses of insulation that should be used on surfaces to be covered. The principles involved in determining economic thickness and economic size of machinery are identical. The desired result in each case is the maximum net saving of money in any given condition.

In determining the economic thickness of heat insulation two methods have usually been used. One method chooses the thickness that gives the lowest annual operating expense, and the other chooses the thickness so that the last increment of thickness pays a required minimum return on the additional cost. In the first case, it is necessary to know the total yearly operating expense of the covered line, which consists of the annual cost of the heat lost through the insulation and the annual fixed charges of the covering itself. In the second case, the yearly operating expense corresponding to the value of the heat lost through insulation is determined for various thicknesses of covering and the yearly saving A of each additional thickness over the previous thickness is calculated. Then the applied cost B of each additional thickness is determined. The per cent return on the additional investment is, therefore $\frac{A}{B} \times 100$.

NOT INFREQUENTLY time and effort spent by engineers to obtain the insulation best suited to conditions have been wasted because of ambiguities in specifications. This concluding article of the series[1] on insulation presents some helpful suggestions to the specification engineer and a chart for determining the economical thickness of insulation at all conditions of temperature, first cost and load factor

It is unnecessary to perform these laborious calculations for most conditions, as, except for high-temperature conditions such as met in the refractory field, charts have been prepared which allow for practically all the variations met in the engineering practice, and from which the economical thickness can be easily determined.

In the chart on the next page *hours of operation per year* refers to the actual number of hours per year that the surface to be insulated is heated. The cost of heat in dollars per million B.t.u. should be the actual value of heat at the point where the insulation is to be installed.

The temperature difference to be employed when using the chart is the temperature of the metal surface over which the insulation is to be applied minus the temperature of the surrounding air. For saturated steam the metal temperature will usually be practically the same as the steam temperature. For superheated steam a metal temperature about 15 deg. lower than the steam temperature is often assumed.

Conductivity values used in the chart are B.t.u. per square foot per degree temperature difference per 1 in. thick per hour. It is well known that the conductivity of heat-insulating materials increases as the temperature is increased. Conductivity values are, therefore, usually plotted as a function of the mean temperature of the insulation, which is the mean temperature of the inner and outer surfaces of the insulation. The inner surface temperature T_1 can be taken the same as the metal temperature, but the outer surface temperature T_2 depends upon the resistance of the outer surface of the insulation. An assumption of an outer surface temperature 50 to 75 deg. above surrounding air temperature will usually be satisfactory.

Insulation cost is given in per cent discount from the standard list prices (see table) and also per board-foot. The applied cost should always be used, remembering that the applied cost for additional thickness is less than would be expected from the list prices of the thicker coverings.

The per cent annual fixed charges to use depends upon the return required on the investment and the depreciation. For power plant work a value of 12 to 15 per cent is generally used. When insulation is to be installed for a comparatively short time, a higher rate should be employed.

Use of the chart is best indicated by an example. Assume that the economical thickness for insulation to be applied on a 6-in. pipe which is at 770 deg. F. is desired and that the following data are also available: (1) hours of operation, 8,250; (2) value of heat, $0.50 per million B.t.u.; (3) temperature difference, $T_1 - T_3 = 770 - 70 = 700$ deg.; (4) conductivity of insulation at the mean temperature of 450 deg. is found to be equal to 0.6; (5) cost of insulation applied is list price less 20 per cent; and (6) per cent annual fixed charges is 15 per cent.

The dotted line on the chart illustrates its use in solving this and similar examples.

[1] Previous articles of this series appeared Sept. 16, 1930; Oct. 7, 1930; Oct. 21, 1930; Nov. 18, 1930; Jan. 20, 1931; April 14, 1931.

Ascertaining the economical thickness as outlined above, and having in mind the characteristics of available materials as covered in this series of articles, it is easy then to determine whether laminated, molded or a combination of high-temperature insulation with a lower-temperature material is required to give most satisfactory results. It is generally accepted that equipment is suitably insulated if the difference in temperature between the surface of the insulation and the surrounding air is between 50 and 75 deg. F. Manufacturers have prepared recommendations of insulation thicknesses for average conditions as an aid to engineers, and which are published in their catalogs and bulletins. In addition these tables contain the total heat transmission through the insulation, the outside surface temperature and, in the case of compound insulation, the temperature at the surface where the two layers meet. These temperatures are of interest, since they indicate that the insulation is working in its proper temperature range and that the heat loss is not excessive.

In the discussion of the use of the chart for determining economical thickness of insulation, reference was made to the cost of insulation. All pipe-covering blocks and sheets are priced on the basis of list prices as given in the table. These list prices were agreed upon in 1907 and are used by all manufacturers and distributors of insulation. For most of the standard types of insulation these list prices are subject to a discount, the quotation being list less a percentage. For instance, 85 per cent magnesia has been selling this year at list less 57 per cent f.o.b. factory. To determine the selling price of 100 sections of double standard magnesia covering for a 4-in. pipe, proceed as follows:

Each section of 85 per cent magnesia is 3-ft. long. Therefore 100 sections are equivalent to 300 lineal feet. Referring to Column *D* of the price schedule, which is for double-standard thick covering, and opposite the nominal pipe size of 4 in, the list price is shown at $1.40 per lineal foot. The list price of the quantity of covering involved is $1.40 × 300 or $420. Since the discount is 57 per cent from list, the percentage applying on the list price is 100 — 57 or 43 per cent. The selling price f.o.b. factory is, therefore, $420 × 0.43 or $180.60.

In determining the selling price of block or sheet insulation, the procedure is similar to that previously outlined for covering. For instance, the cost of 300 sq.ft. of 2-in.-thick magnesia block is calculated as follows:

It is seen that the list price for 2-in.-thick block is 60c. per square foot. For 300 sq.ft. the list price would be $180. Applying the discount of 57 per cent as above, we find that the selling pice is $180 × 0.43 or $77.40 f.o.b. factory.

Preparing Insulation Specifications

Fundamentally, a specification is intended to set forth the requirements of the user, provide suitable methods of application, and facilitate securing comparable bids. A specification should be so worded that there exist no ambiguities, which requires the elimination of generalities. General specifications should have a section for insulating materials, in which is included the insulation specification for each piece of equipment requiring insulation.

Before undertaking the preparation of insulation specifications the necessary information should be available for determining the kind and thickness of insulation best suited to the temperature and other conditions of each piece of equipment. Assistance in this respect can be secured from leading insulation manufacturers, who maintain staff engineers generally familiar with the requirements of industry. Most useful information can be obtained by conferring with the engineers from more

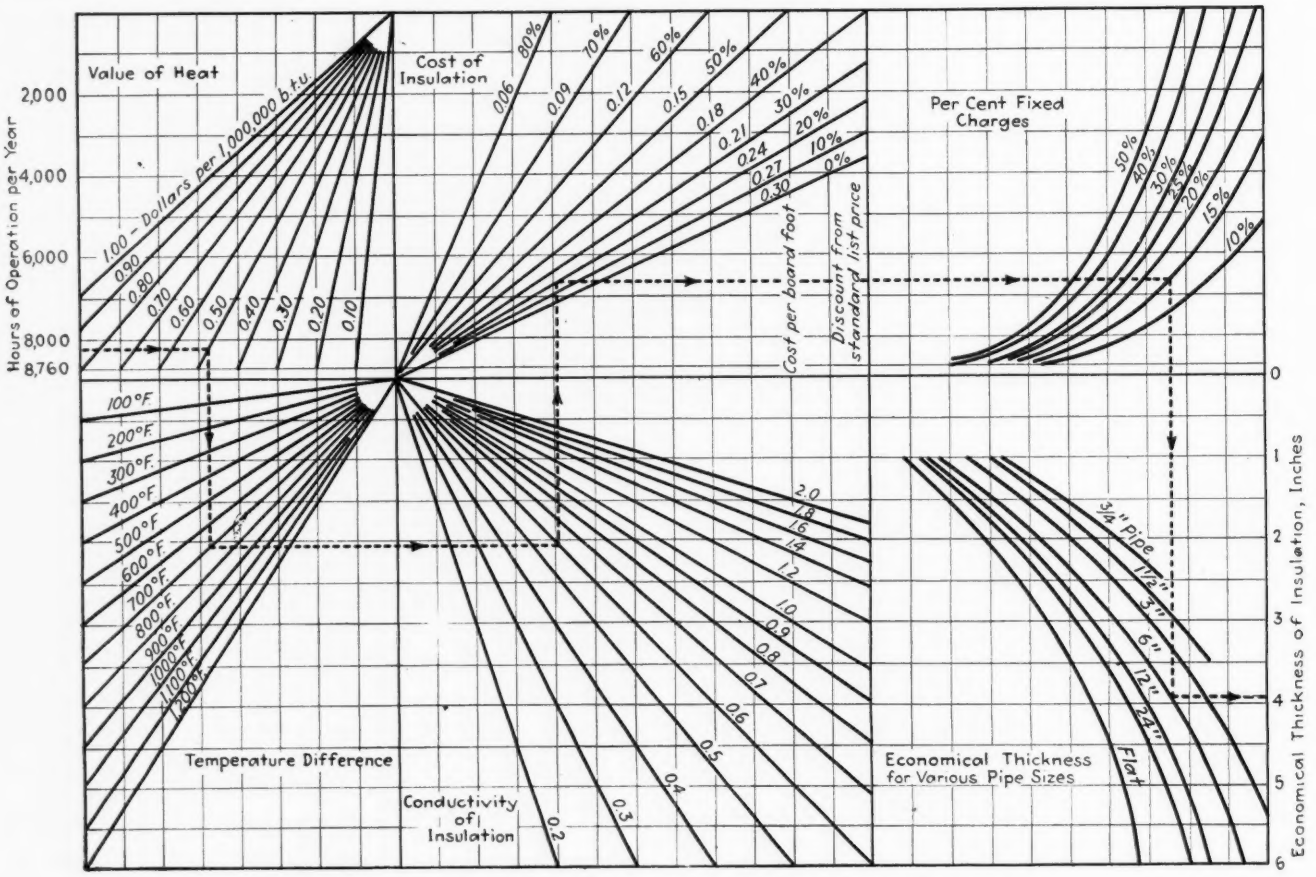


Chart for determining the most economical thickness of insulation to install

than one manufacturer. Such trained insulation engineers can furnish recommendations regarding the most suitable methods of installation, especially if conditions are out of the ordinary.

To enable the purchasing department to secure reliable competitive bids, specifications must be broad enough to permit quotation on two or more brands of a type of insulation, and definitely worded so that no misinterpretation can arise to effect comparison of prices.

Specifications should provide that inspection will be made by the buyer's representative to insure the use of proper materials applied in accordance with the specification and to furnish reasonable co-operation with the insulation contractor.

The phraseology and terms used in a proper insulation specification should be those of the pipe-covering industry, and such that there can be no misunderstanding on the part of the contractor regarding the desires of the engineers. It is important that this be so in order to receive comparable bids and eliminate causes of conflict as the contract is being executed. Due to indefinite specifications, engineers have occasionally straightened out their intention with one bidder and then neglected to inform other competing contractors accordingly. This is unfair to the bidder and may be to the disadvantage of the purchaser. Therefore, it is suggested that no verbal remarks be made on the specification and that any clarifications necessary be done in writing, which should be considered a part of the original specification.

The matter of the insulation of fittings is most important and is usually not clearly covered. The insulation contractor does not consider a flange as a fitting in the sense of what is generally known as a fitting, such as ells, tees, valves, etc. This applies also to flanges of flanged fittings. If flanges are to be insulated mention should be made in the specifications as to the size of piping and fittings on which flanges will occur, so as to remove guesswork on the part of the insulation contractor as to the size of fittings and piping on which they will occur.

A subject that requires more detail than is usually given in heat-insulation specifications is the method of covering fittings and flanges. For example, the specification may read that "all fittings and flanges are to be covered." This specification does not determine how flanges shall be covered, that is, are the covers to be permanent or removable and replaceable. The latter type of flange cover is frequently intended, especially in power plant work, so that leaky flange joints can be quickly and easily repaired without destroying and re-building a flange cover. The difference in cost of flanges of the permanent, and removable and replaceable type is an important item in the final bid.

Often a specification will state that "all pipes subject to freezing, or all pipes liable to sweating shall be covered." Obviously, the determination of what pipes are subject to these conditions is a matter of individual opinion, and it is the responsibility of the specifications engineer to state definitely the lines that are to be covered, to prevent confusion. The reference to pipes subject to freezing and sweating is made only for purposes of illustration; the instance cited refers to other conditions equally as well.

Experience has also proved that when insulation is installed where the canvas jacket constitutes a fire hazard, the canvas should be removed and the insulation proper finished with a fireproof $\frac{1}{16}$-in.-thick reinforced asbestos jacket thoroughly sealed with fireproof glue (silicate of soda) and wired with copper loops on 12-in. centers. Where the asbestos paper jacket is not suitable, an asbestos cement coating, perhaps reinforced with wire mesh, should be employed.

STANDARD LIST PRICES

FOR PIPE COVERING

Nominal Pipe Size Inches	*Standard Price per Lineal Ft. A	1½-In. Thickness Price per Lineal Ft. B	2-In. Thickness Price per Lineal Ft. C	Double Standard Thickness Price per Lineal Ft. D	2½-In. Thickness Price per Lineal Ft. E	3-In. Thickness (Double Layer) Price per Lineal Ft. F	Standard Thickness 85 per Cent Magnesia Covering Inches	Double Standard Thickness 85% Magnesia Covering Inner Layer Inches	Double Standard Thickness 85% Magnesia Covering Outer Layer Inches
½	$0.22	$0.46	$0.75	$0.65	$1.00	$1.20	⅞	⅞	1 1/32
¾	0.24	0.49	0.80	0.70	1.05	1.35	⅞	⅞	1 1/32
1	0.27	0.52	0.85	0.75	1.10	1.40	⅞	⅞	1 1/32
1¼	0.30	0.56	0.90	0.80	1.15	1.45	⅞	⅞	1 1/32
1½	0.33	0.60	0.95	0.85	1.20	1.55	⅞	⅞	1 1/32
2	0.36	0.64	1.00	0.90	1.25	1.65	1 1/32	1 1/32	1⅛
2½	0.40	0.70	1.05	1.00	1.35	1.75	1 1/32	1 1/32	1⅛
3	0.45	0.76	1.15	1.10	1.50	1.90	1 1/32	1 1/32	1⅛
3½	0.50	0.82	1.25	1.20	1.65	2.05	1 1/32	1 1/32	1⅛
4	0.60	0.88	1.35	1.40	1.80	2.20	1⅛	1⅛	1⅛
4½	0.65	0.94	1.45	1.50	1.95	2.35	1⅛	1⅛	1⅛
5	0.70	1.00	1.55	1.60	2.10	2.50	1⅛	1⅛	1¼
6	0.80	1.10	1.70	1.80	2.25	2.70	1⅛	1⅛	1¼
7	1.00	1.20	1.85	2.25	2.40	2.90	1¼	1¼	1¼
8	1.10	1.35	2.00	2.50	2.55	3.15	1¼	1¼	1¼
9	1.20	1.50	2.20	2.70	2.80	3.40	1¼	1¼	1¼
10	1.30	1.65	2.40	2.90	3.05	3.65	1¼	1¼	1¼
*12	1.85	1.85	2.70	4.10	3.40	4.10	1½	1½	1½
14	2.10	2.10	3.00	4.60	3.80	4.60	1½	1½	1½
16	2.35	2.35	3.30	5.10	4.20	5.10	1½	1½	1½
18	2.60	2.60	3.60	5.60	4.60	5.60	1½	1½	1½
20	2.85	2.85	4.00	6.00	5.00	6.00	1½	1½	1½
24	3.30	3.30	4.50	7.00	5.75	7.00	1½	1½	1½
30	4.00	4.00	5.50	8.40	6.95	8.40	1½	1½	1½

*Standard thickness, 1½ in. thickness and 2 in. thickness 85 per cent magnesia coverings are furnished in sections for pipe sizes up to and including 10 in. For larger pipe sizes curved blocks are furnished. All other pipe coverings are furnished in sectional form for all pipe sizes.

The following list prices are to be used for pricing all pipe coverings of corresponding thickness, except that Standard list prices are to be used for pricing all pipe coverings of 1 in. or less thickness.

FOR SHEETS AND BLOCKS

Thickness, In.	Price Square Foot	Thickness, In.	Price Square Foot	Thickness, In.	Price Square Foot	Thickness, In.	Price Square Foot
⅞	$0.30	1½	$0.45	2¼	$0.64	2¾	$0.83
1	0.30	1⅝	0.49	2½	0.68	2⅞	0.87
1⅛	0.34	1¾	0.53	2⅝	0.72	3	0.90
1¼	0.38	1⅞	0.57	2½	0.75	3¼	0.98
1⅜	0.42	2	0.60	2⅝	0.79	3½	1.05
.....	.....	.....	.....	.....	.....	4	1.20

TYPES OF SPECIFICATIONS

There are several types of insulation specifications in general use. The particular specification written is influenced by general company policy, the extensive or limited knowledge of the specifications engineers and leanings toward a particular manufacturer of material or insulation contractor.

There is the so-called open specification which mentions no brand names in connection with the types and thicknesses of insulation specified. This specification, if carefully written to eliminate ambiguities, allows extensive competition, but if careful analysis is not made of bids and the quality of materials quoted on, uneconomical purchasing may result. This unfortunate situation is particularly prevalent in the apartment house and office building business.

There is also the type of specification in which brand names are used in connection with materials. The effect of such brand names depends upon the interpretation placed on them by the purchasing agent. He may con-

strue the names to indicate that only materials of the brands mentioned are acceptable to the engineers, which may be satisfactory if the engineers are well informed and unprejudiced; or the use of brand names may be solely for the purpose of indicating the quality of the materials desired.

In either case, an opportunity should be given recognized manufacturers whose brands have not been mentioned to submit their products for approval before bids are prepared. This is only fair, as the preparation of a bid is an expense to the bidder and it is unreasonable to expect repeated quotations if serious consideration is not to be given the bid.

Unusual equipment requirements sometimes make it desirable to specify one particular brand of material. Such special conditions are sufficient vindication of this procedure. If the specifications include application, sufficient competition can usually be obtained.

Brand names are often used intentionally in specifications to exclude inferior material applied by unreliable contractors. The small building field, to which the unreliable contractor has access, makes this type of specification necessary.

It would be well to recognize that there are unreliable and dishonest contractors in the insulation industry. Their ability to stay in business is made possible by insufficient inspection and by unscrupulous inspectors. There are many jobs done with two-ply or three-ply air cell covering where 85 per cent magnesia may have been specified. The opportunities to "beat" the job are all too frequent. For instance, the insulation contractor on a building may be informed that the bricklayers are ready to brick in a wall that conceals pipes yet to be insulated. The pipe coverers are sent to this location to cover the pipes and their work is immediately followed up by the bricklayers. What is to prevent the unreliable contractor from applying two-ply air-cell where four-ply material or 85 per cent magnesia was specified? This sort of situation exists because buyers are too often "penny wise and pound foolish" in placing contracts, and because the inspector, supposed to supervise pipe covering, among other things, cannot be everywhere at the same time.

There are certain large buyers of heat insulation who prefer a specification entirely different from the types discussed. The specification used by such companies states the temperatures of equipment to be insulated, and leaves it entirely up to the bidder to quote upon a type and thickness of insulation that will give the efficiencies or surface tempertures indicated by the specification and based upon an assumed still-air room temperature. If efficiencies are to be guaranteed, they should be based upon a recognized table of bare pipe losses, which should be included as part of the specifications.[1]

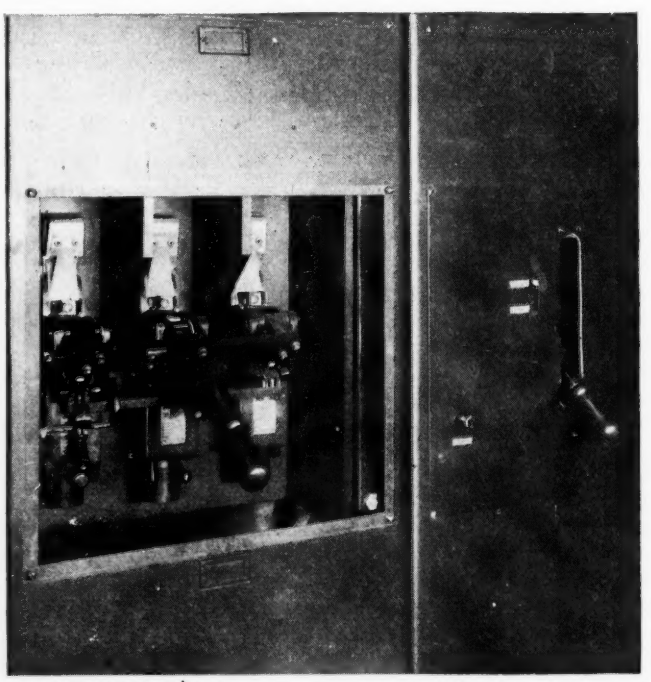
This type of specification usually covers the method of installation and finish of the insulation, and requires certain guarantees that the efficiency or surface temperaure will be obtained and vouching for the durability of the material over a definite period. Buying under such a specification calls for a most careful analysis of all bids by the engineers before the contract can be placed. It requires detailed knowledge of insulating materials and their application. Such a specification should not be used unless suitable technical knowledge is available to advise and direct the purchasing agents' decision.

[1]Article 3 of this series, Oct. 21, 1930.

The attention of engineers and purchasing agents is directed to a situation that unnecessarily works hardship on the insulation distributor and contractor. All too often inquiries for furnishing material and labor are sent out with the statement that bids are wanted almost immediately. The importance of insulation justifies sufficient time for the proper preparation of a worthwhile proposal. It is not always possible for such an inquiry to be given precedence over similar inquiries already on hand. This sort of procedure seems unreasonable, especially in view of the fact that when piping is purchased the layout is usually fairly well determined, and it would appear that this is the time to send out inquiries on heat insulation. The bids could then be properly prepared and the insulation contract closed in ample time before the insulation work need be started. Any changes in layout could be easily taken care of by arrangement with the successful bidder. This is a matter of considerable importance both to the buyer and seller of insulation and is recommended to the consideration of engineers and purchasing agents as a definite step toward simplifying and helping business in the insulation industry.

Cadmium- and Silver-Plated Air Circuit Breakers

A NEW IDEA for the prevention of corrosion is seen in a recent order of air circuit breakers supplied the Craig Shipbuilding Company by Westinghouse Electric & Manufacturing Company. These breakers have all brushes, studs and overload coils silver-plated and all iron parts cadmium-plated to guard against corrosion. The breakers are to be installed on the latest type dead-front steel switchboard for use in a yacht, and consists of 68 three-pole units ranging in size from 12.5 to 800 amperes.



An 800-ampere cadium- and silver-plated air circuit breaker installed in a steel panel, with front cover plate removed

. . . RIGHT OUT OF THE PLANT . . .

Changing an Induction Motor Winding From Single to Double Layer

WHEN rewinding burned-out motors a study of the type of winding, size of wire and turns per coil may indicate that the old winding can be improved. The following describes a change of this kind made in the stator winding of a 15-hp., 220-volt, 3-phase, 60-cycle, 1,140-r.p.m. motor that had failed.

The winding was of the one-coil side per slot type, having 72 slots and 36 coils, each coil having 13 turns

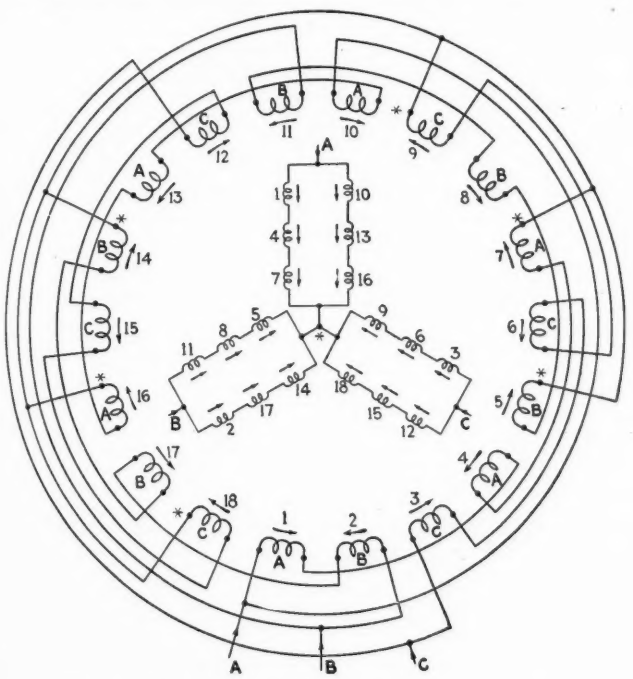


Fig. 1—Thirty-six coils connected into a 2-parallel-star, 3-phase winding

of one No. 10 double-cotton-covered round wire. The coil pitch was 1 and 11 and the winding was connected 2-parallel-star, Fig. 1. This winding required considerable shaping, and No. 10 wire is difficult to shape and wind. It was decided to change over to the conventional two-layer winding and to use a smaller wire.

The change required using 72 coils instead of 36, which, with the same number of turns per coil, would double the turns per phase and require the equivalent of a 4-parallel-star connection for 220 volts. This connection cannot be used with six poles. Since thirteen turns could not be reduced one-half and have an even number of turns, it was decided to change the wire to single-cotton and enamel-covered, two wires in parallel, having a cross-sectional area of 6,000 circ.mil. At the same time the winding connection was to be changed to a 2-parallel-delta with eleven turns per coil, Fig. 2.

To calculate the winding, 36 thirteen-turn coils in a 2-parallel-star connection for 220 volts is good for 440 when grouped series-star. Then with 72 thirteen-turn coils connected series-star the winding would be good for 880 volts. A series-delta connection would be good for $880 \div 1.73 = 509$ volts, and a 2-parallel-delta would be good for $509 \div 2 = 254.5$ volts. Then the turns per coil for 220 volts 2-parallel-delta is equal to $220 \times 13 \div 254.5 = 11.2$, or, say eleven turns.

The wire size selected will require an area of $10{,}380 \div 1.73 = 6{,}000$ circ.mil, since for a delta connection the current per phase is equal to the current per terminal divided by 1.73. Consulting a wire table, it is found that a No. 12 wire has an area of 6,530 circ.mil, but a No. 12 is too large for a mush-coil winding. However, two No. 15 wires in parallel have an area of $2 \times 3{,}257 = 6{,}514$ circ.mil, which is satisfactory. Thus the new winding

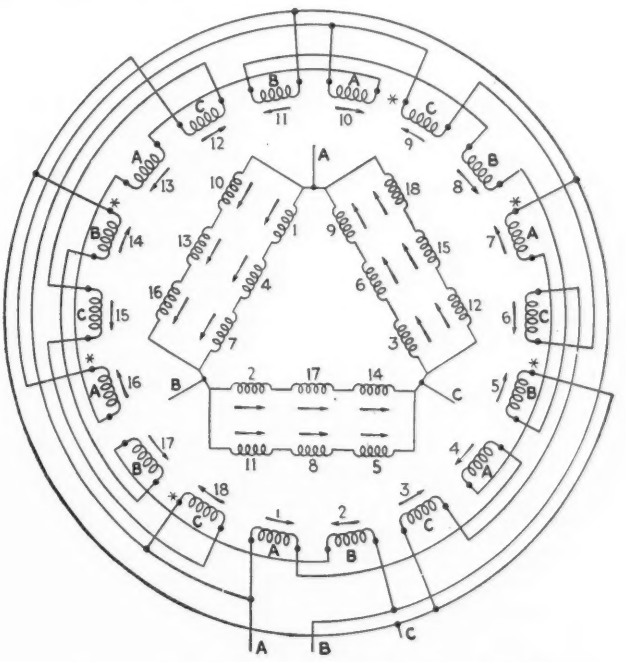


Fig. 2—Seventy-two coils connected into a 2-parallel-delta, 3-phase winding

of eleven turns of two No. 15 wires with enameled and single-cotton covering has more copper area than the original winding and the coils are more flexible.

The new winding was made up of four coils per group, wound flat diamond mush, gang mold. This was done by winding without cutting the wire and eliminated the connections between coils forming a group. The coils were wound into the stator with the throw coils over-

lapping, that is, when starting the winding both halves of the coil were put in the bottom of the slots. When finishing the winding the last coils had both halves placed in the tops of the slots, the same as the last coils in a hand-wound direct-current armature.

By changing this winding a greater copper area was obtained and soldered connections were reduced by the gang winding. Using a smaller wire eliminated stiffness and bad crosses, permitting shaping of coils without damage.

When it is desired to reduce the size of wire used in a winding, change from star to delta connection is useful, as a delta connection requires 73 per cent more turns than a star-connected winding. Also, the cross-sectional area of copper required is 42 per cent less.

Wilkinsburg, Pa. A. C. Roe.

Operating Hydro-Electric Units as Synchronous Condensers

The article by H. A. Von Eiff in *Power* of April 28, the abstract from S. Logan Kerr's paper in Oct. 28, 1930; and H. A. Sieveking's letter, Dec. 30, 1930, numbers, show that operating hydro-electric units as synchronous condensers is receiving attention in America and Europe. The gain in hydraulic efficiency by operating hydro-electric units as synchronous condensers, that is, the saving of a few cubic feet of water per second, is not at present of very great interest to many Canadian hydro-electric engineers. Power-factor improvement by this method has been, however, of considerable importance, and the industrial development peculiar to eastern Canada has caused this method to be adopted in several plants.

In Ontario and Quebec smaller water powers near industrial sites were developed first. Later, the larger and more distant water powers had to be utilized, and the small plants have been reduced in importance as generators of electricity but continue to operate as stand-by stations or as synchronous condenser plants for power-factor improvement.

Illustrating this practice, I have in mind a 4,700-kw. hydro-electric plant in northern Quebec which originally supplied all the power for a paper mill. Today the electrical load has increased tenfold and is supplied by larger and more distant plants, and the older station has taken a secondary place on the system. For a period, this plant's two generators were used as synchronous condensers for power-factor correction. The method of putting the machine in service was simple, and manual. The machines were run up on governor control and synchronized on the bus. Then the penstock valves and turbine gates were closed until there was about one-third normal running pressure within the scroll case. It was necessary to retain this pressure for cooling water for the bearings. About 150 kw., approximately 6 per cent of full-load capacity, was required to drive each machine when running as a condenser.

The two hydro-electric units were used as synchronous condensers for a few years. Then, about 20,000 hp. of synchronous motors was added to the mill load and there was no further need of power-factor improvement. It was found, however, that the two units with heavy flywheels and running at 600 r.p.m. had a steadying effect upon the frequency of the system, and the old station was continued in service.

These units were also used to start two 2,800-hp. synchronous motors by running one of the turbines up to speed and placing it on governor control. The generator voltage was regulated to about 66 per cent of busbar value, and the motor was then switched on to the generator through an oil switch. When the governor had brought the speed back to normal the generator voltage was raised to busbar value. The motor field switch was then closed, and the generator with the motor was synchronized and connected to the busbars. The motor-starting switch was opened and the signal given that the motor was ready for load. This method of starting these motors allowed connecting them to the system without any disturbance.

For a short period, during which the penstock of this station was being repaired, the motors were started from another hydro-electric plant seven miles away. The transmission lines from the second station passed through the first, and disconnecting switches had been installed there. A set of emergency cables with an oil switch was connected to the transmission line. Practically the same method of starting the motors was used, the only variation being that all three generators of the second station were running in parallel when each motor was switched on, instead of only one generator, as in the first mentioned plant.

E. Scott Rivett.

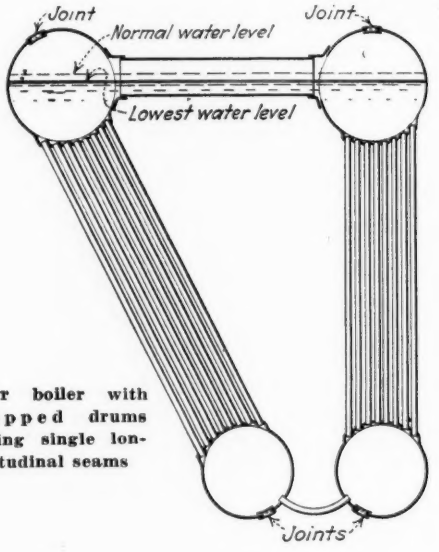
Noranda, Quebec.

Stepped Boiler Drums

It is always well to keep informed about equipment evolved or used in other countries, therefore the article entitled "Stepped Boiler Drums Widely Used in Germany" in the April 28 number was of much interest. It is not likely, however, that this type of boiler will be copied in this country.

To begin with, the illustrations [one of which is reproduced here] do not show how tubes can be either cleaned or replaced. The straight-tube water-tube boiler, manufactured by Henry Vogt Machine Company with stepped drums, has handholes opposite the tubes of such size that each handhole opening will permit of the withdrawal of several tubes. But the Dürr boiler, with joint opposite the tubes, does not seem to have such provision for tube renewal.

While the Dürr boiler has large steam and water ca-



Dürr boiler with stepped drums having single longitudinal seams

pacity, I doubt whether the boiler shown would have fast and free circulation. Correct design principles require positive circulation at high velocity, which means that restrictions in the water flow are to be avoided. Manifestly, the bent tubes shown between the mud drums, having much less area than the other tube banks, must cause much greater speed in the curved tubes between the lower drums than elsewhere in the circuit. These curved tubes should then be exposed to the highest furnace temperature. It would be interesting to know about the furnaces and baffling associated with these boilers, also the location of the superheater and the steam nozzle.

The advantage of straight tubes is obvious, but the expedients necessary to permit their use in this boiler seem, from my point of view, to entirely outweigh this advantage. It will be noted that the tubes are not all straight; also that there must be a tendency for the step surfaces to distort under pressure, and that the complicated shape of drums makes their strength somewhat uncertain.

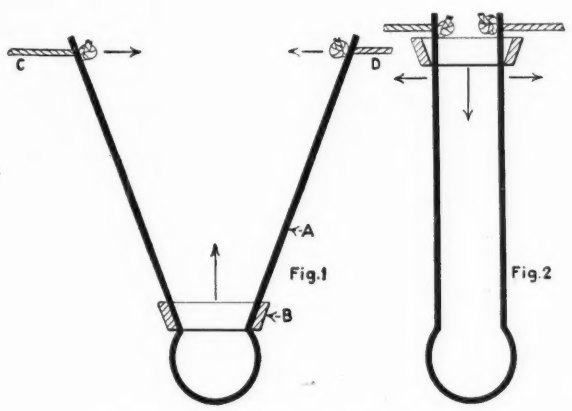
F. E. WERTHEIM.

Chicago, Ill.

Simplifying the Taking of Indicator Diagrams

THE PROCESS of indicating steam engines, though a simple task, is not always considered as such, owing to the difficulty encountered in hooking and unhooking the cord from the engine crosshead.

To overcome this difficulty the attachment shown in the accompanying illustration was devised. The cord is attached permanently to the reducing motion and indicator drum, while the drum is prevented from rotating



Spring clip adjuster for indicator cord

by adjustment of the spring clip as shown. Fig. 1 shows the device open and Fig. 2 shows it closed. *A* is a spring member made of steel, *B* is a sliding collar, *C* is the cord leading to the indicator drum and *D* the cord leading to the crosshead by way of the reducing motion or gear.

With the clip closed as shown in Fig. 2 the cord between the reducing gear and the indicator is at minimum length, thus operating the indicator drum as desired. By sliding the collar *B* down, as in Fig. 1, the cord is lengthened and the rotation of the indicator drum stops.

J. T. TOWLSON.

London, England.

Using Diphenyl-Oxide for Heat Storage

[An editorial in the May 5 number of *Power* stated that the specific heat of diphenyl-oxide is 3.28 times that of water and presented this as one reason for its effectiveness as a heat-storage medium. Actually this ratio applies only to the specific heats per gram molecule, the true specific heat of diphenyl-oxide being less than that of water. To clear up any possible confusion the editor has obtained the following comments from the physicist representing the maker of diphenyl-oxide—EDITOR.]

THE ERROR in the editorial of *Power* on diphenyl-oxide and its uses is not as serious as it might seem, even though the average specific heat of diphenyl-oxide is 0.6 instead of 3.78. The specific heat per gram molecule (3.78) represents the heat capacity of a given number of molecules or a given volume of vapor. The ratio of the usefulness of diphenyl-oxide for heat storage as compared with water, however, is approximately 4 to 1. This is due to the fact that diphenyl-oxide will not only produce preheated boiler-feed water or low-pressure steam, but also high-pressure superheated steam for standard high-pressure turbines.

The specific heat per pound of diphenyl-oxide varies from 0.39 at 80 deg. F. to 0.69 at 800 deg. On account of the high boiling point of diphenyl-oxide, we find that an accumulator operating at a maximum pressure of 150 lb. gage will store 5 per cent more heat per cubic foot, even when allowance is made for the temperature drop required to transfer the heat from diphenyl-oxide to water and also the expansion of the fluids at high temperature. In addition to this, the amount of heat available for conversion into power at a maximum pressure of 150 lb. gage is 1.92 times as much for the same quantity of heat stored. So while a given volume of storage capacity will hold only 1.05 times as much heat in diphenyl-oxide, the amount of power available from that storage is 1.05×1.92, or twice as much.

Now if the diphenyl-oxide is used merely as a heat-transfer medium, for the purpose of carrying heat from the heat absorber to a heat storage packed with iron or gravel the amount of energy stored per cubic foot can again be doubled, making an over-all ratio of 4 to 1. The iron will be found to be about half as expensive per unit of heat stored as diphenyl-oxide, so that altogether new advantages will be derived which were not possible before.

As long as ten years ago J. Ruths experimented on heat-storage systems using such solids as iron for increasing the heat capacity per unit volume. (See United States Patents 1,659,836, 1,666,426, 1,723,302.) He was handicapped by the lack of a sufficiently cheap and stable heat-transfer fluid.

Now it is practical not only to take advantage of this method of heat storage, which furnishes fully preheated boiler-feed water and superheated steam at normal boiler pressure for use with any of the station turbines, but also to use diphenyl-oxide for air preheating and controlling superheat and reheat, and for increasing the peak capacity of a plant by approximating the non-regenerative cycle at high loads. This is accomplished by reducing the amount of bleeding and switching heat carried by diphenyl-oxide from the air preheater to replace the bleeder heat for the boiler feed water.

JOHN J. GIEBE, *Physicist*,

The Dow Chemical Company.

Midland, Mich.

From Among Readers' Problems

Conducted by
L. H. MORRISON

SIZE OF BOILER TO GENERATE 3,000 LB. OF STEAM.—*A horizontal return tubular-boiler is required to generate 3,000 lb. of steam an hour at 100 lb. pressure, using buckwheat coal. I should like to know the diameter and length of shell, size and number of tubes required, also particulars as to grate surface and riveting details.* F.A.B.

One should expect to evaporate 3 lb. of steam per square foot of heating surface of a fire-tube boiler at normal rating. For 3,000 lb., then, you would need a 1,000-sq.ft. boiler.

Since you are to use buckwheat coal, the ratio of grate surface to heating surface should be, for hand firing, about 1 to 30. So the grate area should be 1,000 ÷ 30 = 33.3 sq.ft. A grate length of 6 ft. is about right for a boiler of this capacity. The boiler diameter should be equal to the grate width. The grate width is grate area ÷ length = 33.3 ÷ 6 = 5.5, or, say, 5½ ft. The boiler diameter should then be 66 inches.

A standard 1,000 sq.ft. boiler, 66 in. in diameter should be 16 ft. long and should contain 66 3½-in. tubes. This is a standard boiler and if tubes of less diameter were used, the boiler would have to be built special, making it expensive.

The A.S.M.E. Boiler Code does not permit lap longitudinal seams, so boilers for this pressure should have double- or triple-riveted butt-joint seams with cover plates.

CAUSE OF NOISE IN MOTOR—*Our plant has 5 two-phase, 220-volt, 3-hp., squirrel-cage motors. During the night only one of these motors is used to drive a ventilating fan which is directly coupled to it. If the service switch is opened, the motor emits a growling noise and slows down to about one-fourth normal speed, when the noise disappears and the motor idles slowly to a standstill. The bearings line up and the insulation is all right. The motor gives no trouble during operation and no other motors are connected to the power lines during that time of night. What causes the peculiar noise within the motor when the service switch is opened?* W.V.G.

The noise probably is due either to worn bearings or to the rotor's being loose on the shaft. You say the bearings line up, but have you checked the air-gap all around the rotor? To do this properly requires a long thin gage that can be put through the air-gap at some point and then moved all around the rotor. If the gage can be put through the air-gap at some point on the rotor, and if the rotor is properly centered in the stator bore, the gage can be moved around on the periphery of the rotor for the full circumference of the stator bore.

The rotor should also be carefully checked to see if it is loose on the shaft. It is not always easy to do this by trying to move the rotor on the shaft. If the shaft is examined where it comes out of the rotor, any indications of movement of the rotor will probably be noticed.

LUBRICATING OIL TOO HOT—*In our two-engined diesel light plant the lubricating oil is cooled by tubular coolers, through which part of the engine cooling water passes. At present we are unable to reduce the oil temperature below 150 deg. F. and this is a matter of worry.* J.M.

Probably the water carries scale-forming material, which has so coated the oil cooler tubes that the heat transfer rate is reduced. It is advisable to open one of the heaters and examine the tube surface for scale. The oil may have absorbed water, forming an emulsion or sludge which coats the tubes.

AMMONIA COIL FOR COOLING WATER—*What length of pipe coil, in which there is a circulation of zero ammonia, should be employed for cooling 200 gal. of water per hour from a temperature of 80 deg. to 35 deg. F.* A.C.

The mean temperature of the water would be (80 + 35) ÷ 2 = 57.5 deg. From data of tests under similar conditions, it is estimated that there would be a transfer of heat through an iron-pipe coil at the rate of 105 B.t.u. per hour per square foot of pipe surface, for each degree difference of mean temperature. Hence one square foot of pipe surface would absorb 105 × 57.7 = 6,037.5 B.t.u. per hour.

In cooling the water from 80 to 35 deg. F. each pound of water would give up 45 B.t.u., and for cooling 200 gal., or about 1,666 lb., of water per hour, there would need to be absorption of 1,666 × 45 = 74,970 B.t.u. per hour, requiring 74,970 ÷ 6,037.5 = 12.4 sq.ft. of coil surface, or 12.4 × 2.3 = 28.5 lineal feet of 1½ in. pipe.

This is without any allowance for gain or loss of heat due to the temperature of surrounding atmosphere, extent of tank surface, or character of insulating material employed.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

WE PURCHASE all our power and now find that we need a supply of direct current amounting to about 50 kw. It happens that we still have in the factory a 50-kw. automatic steam engine direct connected to a direct-current generator. One of the men suggests that we connect this to the air line and operate it on air from our compound compressors driven by synchronous motors. Will the engine operate as economically as will a motor-generator set, considering all losses?

SINCE WE MAY CONSIDER the same direct-current generator to be used whether the motor-generator set is used or the steam engine, the efficiency of the generator need not be considered. Then it is a question of the efficiency of the induction motor used to drive the motor-generator, and the compressed-air cycle.

The General Electric Company gives the following efficiency for its induction motors type K. T. 550 volts, 3 phases, 60 cycles:

60 hp.	1200 r.p.m. full load	90%
60 hp.	900 r.p.m. full load	89.5%
60 hp.	720 r.p.m. full load	90%
60 hp.	600 r.p.m. full load	89.5%

The efficiency of the air compressor cycle is the product of the efficiency of the synchronous motor, the air compressor and the steam engine used as an air engine. The efficiency of the syn-

chronous motor depends upon the size and the make, but will probably be between 85 and 95 per cent. The efficiency of the air compressor is low due to the heat evolved in compressing the air, which cannot be used in a reversal of the process, as it was taken away by the cooling water. The efficiency of the unit may then be about 65 per cent. The efficiency of the steam engine when run as an air engine might be as high as 75 per cent. This makes a net efficiency of the air compressor cycle of not over 45 per cent.

This shows the motor-generator set efficiency to be nearly twice that of the air drive. It will have the added advantage of being independent of air compressor failure and a much lower maintenance cost. If a power factor premium is offered by the power company the motor-generator set can be run with a synchronous motor.

The mercury-arc rectifier should be investigated if a high efficiency is desired, as its unit efficiency will be 90 per cent and over on full load. The unit efficiency of the motor-generator will not be over 80 per cent. The mercury-arc rectifier has the added advantage of no moving parts and low maintenance costs.

A rotary converter will give a high efficiency of conversion, but is not in common use for such a small unit. It has a number of disadvantages for such use, so that the mercury-arc unit would be preferred. The nature of the direct-current load must be considered in the choice of the equipment, as a highly fluctuating load would operate best with a motor-generator set.

Salem, Mass. PUTNAM CILLEY.

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IF THIS UNIT were run as suggested there would be four sets of losses, against only two in the motor-generator set.

A simple calculation will prove the point. Assume the following unit efficiencies, which are conservative: synchronous motor driving compound air compressor, 93 per cent; compound air compressor, 75 per cent; over-all steam engine efficiency when using compressed air, 60 per cent; direct-current generator, 85 per cent; new 50-kw. motor-generator set, over-all efficiency, 80 per cent.

Using compressed air in the old engine unit to produce 50 kw. direct-current would require

$$\frac{50}{0.93 \times 0.75 \times 0.60 \times 0.85} = 141 \text{ kw.}$$

With a new motor-generator set, to produce 50 kw. would require $\frac{50}{0.80} =$ 62.5 kw.

Using purchased power at 1.5c. per kilowatt-hour and an hourly load factor of 75 per cent, the costs per hour of operation would be, for compressed-air generation, $141 \times 0.015 \times 0.75 =$ \$1.58 per hour; and for motor-generator set operation, $62.5 \times 0.015 \times 0.75 =$ \$0.70 per hour.

A saving of 88c. per hour would then be available to be used toward the purchase of a 50-kw. motor-generator set. A unit of this size would cost approximately \$1,800, which would be covered by the savings in a short time.

E. W. MACCORKLE, JR.,
Power Engineer,
Kentucky & West Virginia Power Co.
Ashland, Ky.

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THE ENGINE, under ordinary operating conditions, would become choked with frost; so why go further?

Still; suppose the air to be so dry that no frost could form. We now have an interesting lubrication problem, with valves and immediate connections running at a temperature which may be zero or lower. Doubtless it may be solved, but not by me.

Again, heat the air before it enters the engine, to a temperature at least sufficient to prevent frost formation. The engine might now operate successfully with a thermal efficiency comparable with that obtained by steam; say, 25 per cent to be liberal. A motor drive would have an efficiency of nearly 90 per cent.

How much power would be required by the compressor to supply this air? A difficult question, complicated by the fact that a considerable part of the power furnished by the engine is derived from the heating of the air before it enters the engine, not from the compressor. Considering the low thermal efficiency of the engine, it surely must be enough to render the proposition hopelessly expensive.

H. M. PHILLIPS.
Washington, D. C.

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WHICH OF THE TWO suggested arrangements will be the more economical will depend upon several factors, such as load factor of the direct-current generator, cost of power, demand charge for electrical load, present excess capacity of the motor-driven air compressors, etc.

As to actual operating efficiency, no doubt the motor-generator set would be the more efficient. If the motor and generator each have an efficiency of, say, 90 per cent, then the combined efficiency of the installation would be 0.9×0.9, or 81 per cent. But the combined efficiency of the engine-driven unit, from alternating to direct current, would be the product of the efficiencies of the synchronous motors, the air compressors, the air engine, and the direct-current generator. Assuming that these efficiencies would be about 90, 85, 85, and 90 per cent respectively, the combined efficiency would be approximately 58.5.

Now if the direct current is to be supplied continuously at a high load factor there is no doubt but that the higher efficiency of the motor-generator set would justify its installation. But if this current is needed only occasionally it is likely that the saving realized from the motor-generator set would not be sufficient to take care of the fixed charges on the installation.

It is assumed, of course, that the present compressor installation has sufficient capacity to supply the additional air required. If so, this air would be supplied at a higher efficiency than that computed above if the motor-driven compressors are now operated continuously at low-load factor; for the mechanical losses would go on in the compressors anyway, and any additional air delivered to the air engine would not materially increase these losses in the air compressors. Also in this case the electrical demand would likely be lower than if the motor-generator set were used.

My suggestion would therefore be, if the load factor is to be high on the direct-current generator, to use the motor-generator set. If the load factor is to be low, use the existing equipment to save the additional investment that the motor-generator would require.

Beaumont, Texas. M. F. KNOY.

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HAVING BEEN IN CHARGE of compressor plants with several similar problems, I learned from experience that it reduced the power bill and eliminated operating annoyances to follow the principle: "Never use compressed air when you can use an electric motor."

Small steam devices are heavy steam —or air—consumers, particularly at part loads. With the outfit suggested there are the electric losses in the motor and generator, and the air losses in the compressor and engines. Conse-

A Question for Our Readers

MEGOHM METERS, which are widely used, apply voltages ranging from 500 to 1,000, depending on the instrument and the insulation being tested. What relation should the megohm meter's voltage bear to the rated voltage of the machine being tested? Has the insulation of apparatus tested been damaged by the use of a megohm meter?

R.B.G.

Suitable answers from readers will be paid for[1] and published in the July 21 number

[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fritz' *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Annett's *Electric Elevators.*

quently, the transmission loss from alternating to direct current will be very high, most likely well over 50 per cent. Besides, there are twice as many possibilities of something going wrong and more equipment for the operator to attend to.

If first cost is a primary consideration, my suggestion is to disconnect the connecting rod and eccentric of the engine and belt drive the generator by an electric motor.

A motor-generator set will consume less power, and save operating difficulties by keeping the direct-current supply entirely separate from the air-compressor plant.

HOWARD T. LIVINGSTON.

Los Angeles, Calif.

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IT HAS BEEN FOUND that when steam equipment is run on compressed air the weight of air required will be approximately equal to the weight of steam at the same pressure.

Let us assume the operating pressure of the steam engine is 100 lb. gage and the steam rate 55 lb. per kilowatt-hour. Then 55 lb. of air at 100 lb. pressure will be required for each kilowatt-hour produced.

The specific volume of air at 100 lb. will be found by substituting in the formula $PV = RT$, where P = absolute pressure in pounds per square foot, V = volume of 1 lb. of air at given conditions, $R = 53.3$, T = absolute temperature.

$$V = \frac{53.3 \times (460 + 60)}{144 \times 115} = 1.67$$

cu.ft. per lb. of air.

The volume of air at 100 lb. gage = $55 \times 1.67 = 91.8$ cu.ft. per kw.-hr.

Equivalent volume of free air = $\frac{115 \times 91.8}{15} = 705$ cu.ft. per kw.-hr.

An air compressor will require approximately 18 kw. per 100 cu.ft. per minute. Therefore, to secure 1 kw.-hr. of direct current energy by using air in the steam engine $\frac{18 \times 705}{100 \times 60}$ = 2.11 kw.-hr. of alternating-current energy input to the air compressor will be required, giving a corresponding over-all efficiency of 47.5 per cent.

The efficiency of a 50-kw. motor-generator set will be approximately 80 per cent. Therefore, to secure 1 kw.-hr. of direct-current energy 1.25 kw.-hr. of alternating-current input will be required.

The difference in power cost will soon pay for the motor-generator set, and, in addition to supplying the power cheaper than the engine running on air, the motor-generator set will provide a means of correcting power factor by the use of a synchronous motor set.

The example has been worked out, presupposing that 100 lb. air is available in the plant. If, however, air at 70 or 80 lb. pressure is available the weight of air per kilowatt-hour will be greater.

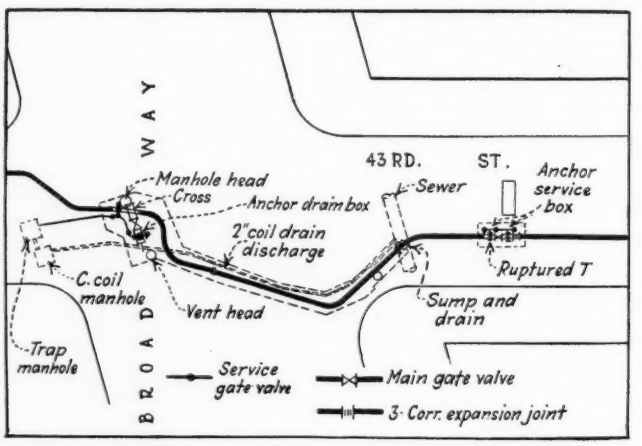
G. E. MARLEY.

Wilkinsburg, Pa.

Water-Hammer Caused Steam-Main Rupture

AN ILLUSTRATION of how outside influences affect the operation of steam-distribution systems was afforded by a break in a cast-iron fitting in a 12-in. steam main of the New York Steam Corporation, which, investigation disclosed, was due to water from a ruptured 20-in. city water main that extends north and south on Broadway. No damage was done to neighboring property by the escaping steam, nor was any personal injury sustained.

A 20-in. steam main operating under a pressure of 135 lb. gage extends north and south on the west side of Broadway, and at the intersection of West 43d St. a 12-in. lateral steam main extends eastward from the Broadway main, passing beneath the 20-in. water main and through a manhole maintained by the steam corporation in 43d St. about 35 ft. east of the east curb line of Broadway, this steam main terminating at a point about 185 ft. further east. The connection with the Broadway main is made to a 20x12-in. so-called anchored service box, and the bottom of the 12-in. outlet is level with the bottom of the 20-in. fitting. An offset bend in the 12-in. lateral, lying in a horizontal position, extends south and then east of the box and connects to a length of pipe 24 ft. 3 in. long. Connected to the easterly side of this pipe is another offset bend, which extends north and then rises 7 ft. 6 in. as it extends east, with the easterly flange connected to an anchored cast-iron service box 12 in. in diameter, with side outlets 3½ in. in diameter. This is followed by a 12-in. valve, another service box connected to the east side of the valve, and then a 12-in. expansion joint on the east flange of the second box, and from where the main continues eastward 185 ft. to a dead-end.



Plan of main, showing location of fitting that failed

The rupture occurred on the 12-in. box connected to the bend in elevation. The main, including the offset bends, is housed in a concrete conduit and insulated with two inches of asbestos sponge covering with a double layer of waterproof roofing material. The roofing material does not serve as a definite waterproof, nor would it prevent contact of water with the pipe if the main were submerged. A connection to the sewer from the conduit provides drainage for seepage water that may enter.

Continuous-flow traps are provided to eliminate the condensate from the main and are connected to a fitting at the west side of the connection on the Broadway main. These traps have capacity to discharge approximately twenty-five times the normal quantity of condensate collected at this point. The main is graded and the drainage of condensate is counter to the steam flow.

Following the break of the water main, water flooded the Broadway sewer and, backing up through the conduit drain of the steam main, submerged that main, creating an extremely high rate of condensation within it which was apparently in excess of the discharge capacities of the steam traps. The steam main thus soon filled with condensate and a water-hammer was created that apparently reached its peak pressure at the previously mentioned fitting. The rupture occurred fifteen minutes after the water had been discovered seeping into the transit subway.

A piece of metal, triangular in shape, 10 in. wide at the base and 2 ft. long was completely severed from the south wall of the box. The copper expansion joint was affected also by the force of the water-hammer, but in this member the only effect was a broken equalizing ring and a bulge of the copper metal of the corrugation, without fracture of the metal itself.

Because of the vertical rise in the pipe, the water, which collected in the conduit, did not reach the fittings that followed, precluding the theory that the rupture might have been due to a rapid thermal contraction of the pipe by the sudden cooling of the line. Engineers of the company state that the fact that this particular fitting was of cast iron has no signficance, because, in other cases, failure has occurred in the pipe and a cast-iron fitting close by was left unaffected.

The rupture occurred at 1:55 a.m. Steam to this main was completely shut off by 3 a.m., a new service box and expansion joint was installed and service resumed at 10:20 o'clock of the same morning.

National District Heating Association Discusses Problems at Boston

Effectiveness of heating-system temperature-control equipment, corrosion of return piping, boiler feed-water treatment and control of air to stokers were among the problems discussed at the association's twenty-second annual convention

THE National District Heating Association on June 2 to 5 held its twenty-second annual convention in the historical city of Boston, where the 195 who attended the meeting enjoyed the hospitality that New England is famous for. Although generally a poor year for conventions, this meeting had next to the largest attendance of any previously held by the association.

The convention was opened by an address of welcome by C. L. Edgar, president of the Edison Electric Illuminating Company, of Boston. G. L. Gaskell responded to the welcome. The association's president, L. S. Smith, presented his annual address, which traced various developments during the year and particularly stressed the association's new handbook now nearing completion. Reports of the executive committee, treasurer, and committee on amendments followed.

Technical sessions were started in the afternoon with the report of the research committee, which was presented by its chairman, E. E. Dubry. The report dealt mostly with the combination-service utility plant that supplies both power and steam to industries. Several examples of such plants were briefly described. Also the question of byproduct power generation by central heating plants was discussed. Steam conditions of 1,400 lb. pressure and 750 deg. temperature were given as the optimum for a plant designed for byproduct generation.

Conditions in District Heating Industry

The report of the committee on operating statistics contained summaries of replies by member companies to an extensive questionnaire. Over the entire territory the gain in connected load indicated was 1,800,000 sq.ft. of equivalent direct radiation, or slightly more than 5 per cent. Due to mild weather the sales of steam were 6.5 per cent less in 1930 than in 1929.

The analysis given of station operation indicates that distribution losses have decreased from 19.2 to 17.2 per cent of station sendout, and that the average load factor had dropped 1.5 per cent to a value of 26.7 per cent for 1930.

In discussion J. E. Seiter suggested that the use of steam to reactivate silica gel as used for air drying might be a means of improving the summer load and help to raise the load factor.

The report of the station operating committee contained five separate papers; one by M. D. Engle, "The Ideal Boiler Plant for Steam Heating Service"; "An Improved Air-Control System for Stokers," by E. M. Brown and A. S. Griswold; "Report on Feed-Water Treatment," by A. R. Mumford; "Report on New Plants and Additions," by R. M. Nee; and a table showing boiler availability and causes of outage, by A. S. Griswold.

The paper on the ideal boiler plant was based on a study made before the design of the new Kneeland Street steam station of the Edison Electric Illuminating Company. Mr. Engle pointed out that with only half the load factor of the electric utility plant only half as much can be invested for obtaining higher efficiencies. Simplicity is desirable, and each major item of equipment should operate at nearly its maximum capacity when its boiler unit is at full load, but that no relatively inexpensive equipment should limit the capacity of the major equipment.

All of the major items of equipment were discussed separately in the paper, and recommendations and design principles given in each case.

Air Distribution Control Improves Stoker Efficiency

The stoker air control system described in the paper by E. M. Brown and A. S. Griswold consists of two rectangular venturi throats which measure the air to two sections of each tuyère stack, and four additional throats on each side of the ashpit of the double underfeed stoker measure the air to the moving and stationary extension grates. Each venturi throat is equipped with indicating pressure gages from which the air flow is determined, and a damper for regulating the air to each section as fire conditions require.

With this control it was possible to maintain 2 per cent higher CO_2 and to increase the capacity of the boiler from 435,000 lb. of steam per hour to 535,000 lb. per hour. It was found that only 60 per cent of the air flows through the tuyères and extension grates and the remaining 40 per cent leaks in through small openings around the pushers. A more complete abstract of this paper will be published in a future number of *Power*.

In answer to questions E. E. Dubry replied that the control system introduced no operating difficulties and that slice bars were never used.

The report on feed-water treatment presented by Mr. Mumford described a new method of controlling the admission of caustic soda to the boiler-feed system at Kips Bay. It is claimed that when the pH value of the feed water is maintained at 9.6 or above the corrosion of pre boiler equipment is kept at a minimum.

Analysis of boiler water taken from various parts of the Ladd-type boilers at Kips Bay indicated a great variation in the concentration of the various constituents. Concentration was two to three times higher in samples from the water columns and from the deconcentrator connected to the steaming drums than in the mud drum samples. A more extensive knowledge of the variation in concentration is needed to permit the water to be treated for maximum protection to the boiler.

Discussion brought forth an inquiry as to why internal treatment was used, to which Mr. Mumford replied that there is not room available for equipment necessary for external treatment. He also expressed the belief that dissolved oxygen is a secondary cause of corrosion and that control of pH value is more important.

The evening session was devoted to the report of the meters and accessories committee. H. M. Hammond presented a description of various types of steam-flow meters, and M. Conaty outlined the history and development of condensation meters. This paper also contained curves showing the effect on meter efficiency of water temperature and meter capacity.

In discussion it was suggested that a specification be prepared that would indicate to the manufacturers the requirements of meters used in district steam systems.

The first paper presented at the Wednesday morning session, which was

presided over by J. E. Seiter, was the report of the Commercial Relations Committee, presented by its chairman, S. S. Sanford. The first part of the report dealt with a survey made to obtain information concerning different types of temperature control equipment. Twelve different types of temperature control equipment are listed in information received from 70 office buildings and 44 other buildings of various types. In the report the performance of various types of temperature control equipment was compared on the basis of steam consumption in pounds per degree-day per thousand cubic feet of gross volume, per thousand cubic feet of heated space, and per thousand square feet of direct radiation. The authors were careful to caution against drawing conclusions from the table, for in only two cases were there enough buildings in any one group to make the results at all conclusive. The lowest steam consumption reported is with an average consumption of four buildings in which the steam consumption per degree day per thousand cubic feet of gross volume is 0.554 lb.; per thousand cubic feet of heated space, 0.691 lb.; and per thousand square feet of radiation, 42.7 pounds.

A section of the report dealt with heat exchangers for economizing the heat in system returns. The direct use of condensate for hot-water purposes appears to be increasing in popularity, as several new installations are reported.

In discussion, L. S. Smith commented on the fact that the tables comparing the performance of temperature control equipment seem to indicate that the most expensive systems are not necessarily the best. Further discussion indicated that it was generally felt that the data do not permit of comparison of various types of temperature control, but do indicate that great savings are possible with temperature-control equipment. It was also pointed out that poor piping in the heating system would greatly influence the steam consumption, as would the presence of other heat-emitting equipment, such as motors and excessive electric light.

New Use for Steam During Summer

R. W. Waterfill presented a paper which described various types of refrigerating systems, and H. R. Warfield discussed the use of silica gel as a dehumidifying agent for air conditioning. The silica gel granules will absorb water up to 30 to 40 per cent of their own weight without swelling and will reduce the due point to as low as 30 deg. Steam at 150 lb. is used to reactivate the silica gel at intervals of 40 minutes. One of the advantages claimed for this system is that the air cooling and dehumidifying are entirely separate processes, and each can therefore be controlled separately.

At this session the nominating committee reported as follows:

For president, W. W. Stevenson; for first vice-president, E. E. Dubry; second vice-president, J. E. Hillemeyer; third vice-president, W. J. Baldwin, Jr.; secretary-treasurer, D. L. Gaskill. Those nominated for the executive committee were L. S. Smith, F. E. Engle and H. Warhanek.

At the Thursday morning session Edward Lenz presented the report of the distribution committee, which discussed the distribution line losses and unaccounted-for steam. Data from sixteen companies indicated that the line loss in per cent of total sendout varies from a minimum of 6.6 to a maximum of 42 per cent. These losses represent the difference between the station meter readings and the meter readings at the consumer's premises. From the data available it was not possible to find any basic relation between losses of the various companies.

In addition to the committee's report, Mr. Lenz presented tabulations containing brief information as to construction methods and equipment favored by seventeen different central heating companies. This material was prepared by A. D. Leach.

Survey Indicates Extent of Return Line Corrosion

The committee on corrosion endeavored to determine the true nature and extent of corrosion troubles and to accomplish this result sent an extensive questionnaire to member companies. Twenty-seven replies were received, and the results were presented by J. H. Walker. Twenty of the twenty-seven reporting companies indicated that they had experienced corrosion in customers' buildings, and that the severity varied considerably. One company reported the average life of a return pipe to be about seven years. Corrosion apparently takes place almost entirely in return lines. Only two companies indicated that corrosion was evident in the steam distribution piping.

Mr. Walker reported progress in the use of 600-W automobile oil introduced in the heating line to inhibit corrosion. Indications are that this oil is distributed throughout the heating system and into the return line. It was noted that there is slightly more oil at the bottom than at the top of the return pipe. Other tests are being made to determine the effects of corrosion on various types of material and pipe coatings by installing test specimens in the return lines of a heating system and observing them under actual operating conditions. A corrosion test cell was also described which may be inserted in the return line. The cell consists of a porcelain spool upon which wire of any desired metallic composition is wound. The wire used is approximately 0.003 in. in diameter, and its corrosion is relatively rapid and the extent is easily measured. The apparatus has the unique advantage that when once installed specimens can be removed at will. At this session James Aston presented a paper that described the fundamentals of corrosion, and E. R. Benedict read a paper on methods of welding pipe.

In the discussion of the report of the corrosion committee belief was expressed that odors from oil injected into the piping system might be objectionable in the case of single-pipe heating systems. It was reported that sodium silicate has been used with some success as a rust inhibitor in domestic hot-water systems.

Mr. Slade, of the District Steam Company, reported that there seemed to be a tendency to call for expansion joints having a traverse of 18 to 40 in., and questioned their advisability. He also reported a tendency toward steel expansion joints, and that anchors are being welded to the expansion joints on the job instead of cast integrally with them.

At the Friday morning session H. P. Bussmann presented an address on sales promotion in district heating, and the sales promotion committee also reported. At this session the association voted to elect those officers presented by the nominating committee; also to adopt the amendments to the constitution which the committee on amendments had proposed at the first session of the convention.

Extensive arrangements had been made for entertaining the delegates. The ladies were entertained on Tuesday at the glass flower exhibit at Harvard University, and at a theater party in the evening. On Wednesday afternoon a special trip was arranged to historical places in and around Boston, which included a shore dinner at the "Fo'cas'le" at Marblehead.

Thursday afternoon a golf tournament was staged at the Commonwealth Country Club, and, in addition, various trips were arranged to the Edison Electric Illuminating Company's plant at Kneeland Street and Edgar station at Weymouth. In the evening the annual banquet was held.

Gatineau Power Company Makes New Output Record

Gatineau Power Company, a subsidiary of Canadian Hydro-Electric Corporation, Limited, recently made a new high output record for a single day by producing 9,102,120 kw.-hr. of electric energy. This is eight per cent over the high record made by the company a year ago.

Output of electric energy of the Gatineau company thus far this year has averaged 3.5 per cent greater than during the corresponding period of 1930, and more than 20 per cent over the same period of 1929. Output in the month of April was 9 per cent greater than that in April last year.

Net earnings of Gatineau Power Company for the twelve months ended March 31, before interest and reserves, were $6,916,633 as compared with $5,635,987 in the preceding twelve months. Consolidated net revenue of the Canadian Hydro-Electric Corporation for the first twelve months ended March 31, after all charges, was $2,044,607.

Smoke Abatement, Distribution Costs Among Topics of N. E. L. A. Convention

THIS YEAR the 54th convention of the National Electric Light Association in Atlantic City, N. J., was attended by about 5,000 delegates, or approximately half the usual number. While lacking in this respect there was no dearth of enthusiasm or faith in the future of the electrical industry shown at the meeting.

The exhibition offered splendid representation by about 220 manufacturers, many of whom showed marked originality in their displays. Equipment for office, substation, power house and household as built by most of the leading companies was on view.

Special meetings of the executive committees were held on Monday, June 8, and general sessions as well as those of the various sections carried through from Tuesday until Friday.

Presiding at the engineering section session on Tuesday, Chairman Alex D. Bailey reviewed the growth of the section and pointed out the value of participation in its activities of the section. George H. Tidd, president of the American Gas & Electric Company, spoke on the great economic waste in the industry represented by the number of accidents and fatalities among the public utilities and made a strong plea for teaching the individuals a greater sense of their own responsibilities.

Four Classes of Smoke Reformers

He was followed by Dr. Harvey N. Davis, president of the Stevens Institute of Technology, who spoke upon the lay observer's view of the air pollution problem. "There are four classes of propagandists," he said, "those who preach smoke abatement wholly from the economy and reduction of fuel bill that will result; those who emphasize property damage from soot, cinder, sulphurous fumes and the like; those who stress the effect of these elements upon public health; and those who fight for pure air on psychological grounds. The last is the group which Dr. Davis thinks needs most attention from the public utilities. He pointed out that the interests of the first three groups were also the interests of the utilities but that the utilities would, as time went on, be forced to consider whether it would not pay to buy the contentment of the fourth group at almost any reasonable price by adding to their plants the necessary equipment to satisfy them despite the cost.

He then reviewed the difficulties in the promulgation of a wholly satisfactory smoke ordinance when as yet there were no entirely acceptable standards or methods by which stack nuisances could be accurately determined. In emphasis of this he cited a case where it is proposed to fix the content of fly ash in gas streams which will constitute a nuisance. The first plan was to state that more than 200 grams of solids per 1,000 cu.ft. of gas was a nuisance. This was later changed to 300 grams and on further consideration to 400 grams.

"If there is this range of variation in the thoughts of people who are supposed to know," he asked, "why should any attempt be made at this time to fix the amount at all, until more is known of what it should actually be?" In Dr. Davis' opinion such a provision coupled with the fact that it would probably cost from $800 to $1,500 for each effort to determine whether the specified solids are being discharged, would make a joke of the ordinance and the cause would suffer accordingly.

The public utilities, he thought, would find no objection to meeting the provisions of any law to abate smoke because to do so would reflect a saving in operation, but to reduce the amount of fly ash would be less popular since while the people wanted it, the accomplishment would mean money out of the pockets of the power companies.

Then after discussing the difficulties in the establishment of suitable setting heights for boilers and the control of sulphur fumes, he spoke of the need for all interests to organize on a rational, decent, friendly basis and cooperate for the settlement of these problems.

It was his hope that the pure air committee organized for this purpose by Ely C. Hutchinson under sponsorship of the American Society of Mechanical Engineers would meet this need and that it would eventually develop into a committee with such prestige as has been gained by the boiler code committee of that society.

He closed with the prophecy that 25 years hence none of the cities will be using raw coal but will find it simpler and more economical to use processed fuel from which the objectionable matter shall have been removed and disposed of as by products.

Investigation Made of Distribution Costs

Following Dr. Davis a report on distribution costs in residence service by A. C. Marshall, vice-president and general manager of the Detroit Edison Company, and H. A. Snow, assistant controller, was read by Mr. Marshall. In answer to public pleas for information on this subject the report develops, step by step, the cost of every item from the coal pile to the meter in the consumer's cellar, together with the charges for general expense and "overhead," so often overlooked by critics of the electric light and power industry. While localities with diminished consumer purchasing power, or leaner and less densely populated areas, will necessarily show higher costs of service, (and so bringing up the over-all national average), the typical prosperous industrial city selected by the report shows that the services which have nothing to do with the amount of current used cost the utility more than all the expenses of generation. It was found that the entire expense of generation, at the power house busbar, was 1¼c. a kilowatt-hour, while the total cost of the electric current itself delivered at the consumer's meter was 3.48c. a kilowatt-hour. To this must be added certain business and service costs such as lamp and fuse renewals, repairs to appliances, trouble calls of all kinds, meter reading, billing, collecting and bad debts, instruction, home service work, advertising, etc., amounting to 1.8c. a kilowatt-hour, bringing the total cost to the utility company up to 5.28c. a kilowatt-hour used, which is slightly more than four times the cost of production.

The report concludes by calling attention to the fact the lower unit costs may only be obtained through the stimulation of greater use of current by the domestic consumer.

Engineering and Accounting

In a paper read before the accounting section session on Tuesday, H. W. Fuller, chief engineer of the Byllesby Engineering & Management Corporation, explained the relations of the engineer and the accountant and the necessity for the closest kind of cooperation between them.

The accountant "is especially skilled in recording and analyzing receipts and expenditures of money so as to convey to others information needed for purposes connected with the business to which the accounts relate," he said. "The function of the public utility engineer is to work out in detail the best, usually the most economical, method of supplying the ascertained or prospective needs of the properties. . . . Accurate estimates can be made only if the engineers have available for their use dependable costs, usually unit costs, actually experienced in comparable work, so the engineer asks the accountant to set up his accounts in such a way that they will yield this kind of information."

Announcement of officers elected for the coming year was made at the concluding session on Friday, as follows: President, J. F. Owens, president of the Oklahoma Gas & Electric Company; vice-president, Marshall E. Sampsell, Central Illinois Public Service Company; Edwin Gruhl, North American Company; Paul M. Downing, Pacific Gas & Electric Company; and John P. Coghlan, Pacific Gas & Electric Co.

WHAT'S NEW IN PLANT EQUIPMENT

Mercury Column Gage for Low Pressure and Vacuum

Type No. 410 column

IMPROVED mercury column gages for pressures up to 25 lb. and for vacuum are now being offered by the Amthor Testing Instrument Company, Inc., 309 Johnston St., Brooklyn, N. Y. The glass tube is mounted in a U-shaped scale case and the mercury level stands out sharply against the white backing of the glass tube. Depressed black graduations and figures present a clear and distinct reading, visible from a distance. Any one of the right, left or top connections on the mercury chamber can be used.

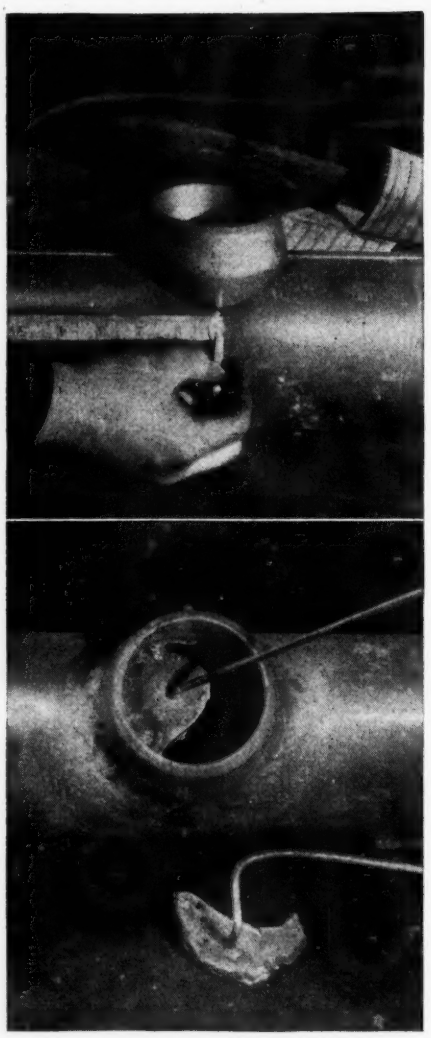
Welding Fittings for Making Branch Connections

TO MEET THE NEED for a welding fitting that will simplify the making of branch connections on main pipe lines, the Bonney Forge & Tool Works, Allentown, Pa., has introduced a line of fittings known as "Weldolets" and "Thredolets."

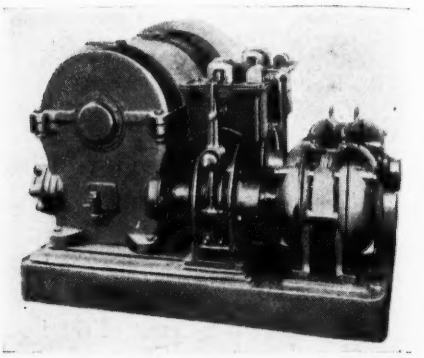
Made in various pipe sizes from ½ to 10 in. to fit on pipe from 1 to 12 in., these fittings are designed to be installed by simply welding them to the main line using a fusion or vee-weld, then removing the button and completing the junction by welding or screwing the branch pipe to the outlet. The fittings are drop-forged, and have a heavy external rib, which in addition to increasing the strength is said to dissipate the excess heat when welding, thus preventing shrinkage and distortion.

As supplied, the fittings have a beveled vee edge along the surface which comes in close contact with the parent pipe and thus permits the use of the improved fusion or vee-weld.

The fittings are placed on the parent pipe (as shown in the upper view) in the exact location and at the angle at which the branch is to be taken. They are first tacked, then welded fast. After the fitting is welded, an S-shaped cut is made inside the outlet of the fitting, and the button is removed in two pieces as shown in the lower view.



Fittings are located at proper point on main pipe, then welded and center cut out



Elevator drive consists of two complete hoisting machines combined in one unit

Duplex Elevator Uses Standard Squirrel-Cage Motors

IN ADDITION to its standard types of elevators, the Watson Elevator Company, 407 West 36th St., New York City, has introduced a new design of hoisting machine known as the Duplex Elevator, which is said to effect considerable economy in initial cost, maintenance and power, as well as to insure precision floor stops and uninterrupted operation.

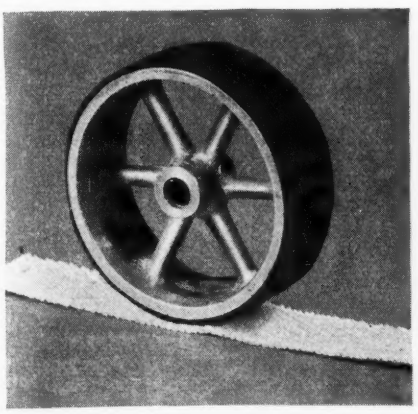
One of the principal features of the new elevator is the use of low-cost, single-speed, high-speed, squirrel-cage alternating-current motors. The elevator consists of two complete hoisting machines combined in one unit which drives a traction sheave through differential gears, one machine being geared to drive the sheave faster than the other. A range of car speeds is thus provided from full (the sum of the speeds of both drives), through half (at which either drive alone operates full load), to slowest (the difference in speeds of both drives), which, according to the manufacturer, gives a precision leveling speed as slow and positive as variable voltage.

Uninterrupted operation is assured by the fact that either complete hoisting machine alone can operate full load at half speed, service stoppage being possible only through the simultaneous failure of both. Either machine, its motor or controller can be repaired during regular working hours without interrupting the elevator service.

Pulley Covering Reduces Slippage on Belt Drives

THE INJURIOUS EFFECTS of slippage on a belt drive and the loss of power and increased wear and tear on equipment through the use of overtight belts in an attempt to reduce the slippage are now well known and appreciated by engineers.

In an endeavor to eliminate these troubles and to improve the efficiency



Gripwell applied to pulley

of a belt drive, a pulley surface covering known as "Gripwell," designed to improve the frictional contact between the belt and pulley face, and thereby reduce the slippage to a minimum, has been developed by the Gripwell Manufacturing Company, 110 West 34th St., New York City.

Gripwell is a special compound and is used in connection with a treated canvas, producing a covering which when applied to a cast-iron, steel or wood pulley is said to produce a semi-elastic, gripping surface which reduces the belt slippage. The compound contains preservative properties, which penetrate the pores of the belt and tend to keep it in a pliable and healthy condition.

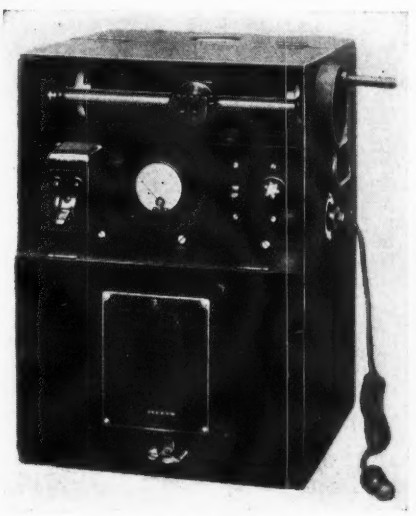
It is pointed out by the manufacturer that with this product, properly applied, belts can be run much slacker than is the general practice without the use of tightener or idlers, and that reduction in slippage from excessive amounts to less than one-half of 1 per cent has been made on drives where the service is severe.

Portable Transformer Oil Test Set

IN THE AMERTRAN Type TS-6B test set illustrated for testing transformer oil, safety has been insured by completely inclosing all high-potential parts and by locating the oil cup in a compartment equipped with a switch which functions to open the power circuit when the lid is raised. The cover to this compartment is also fitted with a glass window to permit visual inspection of oil during a test.

An improved voltage regulator is used consisting of a collapsible crank mounted on the outside of the case and coupled to the potentiometer slider through a worm gear. This makes possible the smooth increase in test voltage from zero to maximum at a rate of approximately 3 kv. per second.

The set is housed in a welded sheet-steel case of compact design and employs a 30-kv. testing transformer with a rating of 0.5 kva. Other equipment includes circuit breaker,



Type TS-6 oil-test set

voltmeter, potentiometer, pilot light, power switch and detachable cord for connecting the set with 110-volt, 60-cycle power circuits. It is manufactured by the American Transformer Company, 178 Emmet Street, Newark, N. J.

Thermoplastic Compound

DIELECTRIC STRENGTH twice as great as that of vlucanized fiber is one of the principal features of "Codite," a thermoplastic compound developed by the Continental - Diamond Fibre Company, Newark, Delaware. The dielectric strength is 523 volts per mil for tubing 5/16 in. in internal diameter by 13/32 in. in outside diameter. It is increased to 710 volts per mil for tubing 5/16 in. in internal diameter by $\frac{3}{8}$ in. in outside diameter. It can be machined easily and accurately and its surface is capable of taking a high polish.

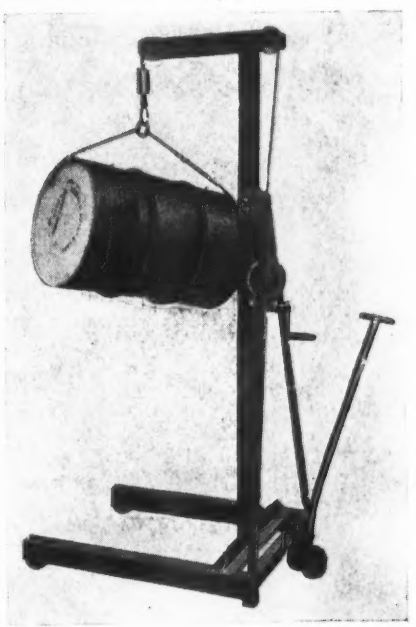
Hard-Bronze Bearings

BUSHINGS AND BEARINGS made of a hard low-friction, phosphor-bronze alloy are announced by The Bunting Brass & Bronze Company, Toledo, Ohio. These products are offered for applications where hardness and ability to withstand pounding are particularly essential, together with the low friction and minimum wear assured by a leaded phosphor-bronze alloy. The lead content may vary from 5 to 25 per cent, depending upon the type of service required.

General-Utility Portable Crane

BUILT IN CAPACITIES OF 500 to 2,000 lb., in four types, hinged, telescopic, revolving hinged and revolving telescopic, the portable crane illustrated is adaptable to a variety of uses around power and industrial plants, such as lifting and transporting motors and other auxiliary equipment.

In the hand-driven unit, intended for short lifts and intermittent service, the worm has the self-locking feature requiring no brake. Units equipped with motor drives ranging from $\frac{1}{2}$ to 3 hp. are provided with master line switch, thermal overload protection and automatic limit stop. Units with an air-motor or gas-engine



Hand worm-driven crane with hinged upright

drive are available. Lifting heights range from 6 to 14 ft. The crane is put out by the Lewis-Shepherd Company, Boston, Mass.

NEWS of the FIELD

Automatic Welding and Smoke Regulation Discussed at Boiler Manufacturers Meeting

THE 43RD ANNUAL CONVENTION of the American Boiler Manufacturers Association was held at Skytop Lodge, Skytop, Pa., on May 25 to 27 inclusive, each of these days being so planned with morning and evening sessions, as to allow free afternoons for recreation and the social contacts.

President H. H. Clemens opened the general session Monday morning with an address on conditions in the boiler manufacturing industry and the work of the association toward the improvement of trade practices.

The evening session was devoted to the subject of fusion welding, with Dr. Comfort A. Adams, president of the Welding Engineering & Research Corporation, as the principal speaker. He stressed the great difference in the type of skill and the background of knowledge required in welding operations, as compared with the usual method of boiler construction requiring rolled plates, dished heads, and rivets. In fact, the introduction of fusion welding into mechanical processes has made it necessary to bring science, research and a knowledge of metallurgical chemistry into business that have previously found their knowledge of mechanical engineering to be sufficient, he said.

It was the opinion of Dr. Adams that no concern that was not prepared to accept the entry of these new elements into its organizations and to modify its thought to include and recognize their primary importance, should attempt to do metallic arc welding. He further gave it as his opinion that the X-ray examination of all welds after completion was the best method to determine the satisfactory and acceptable condition of the welded seam. He said that an intelligent operator should be able to successfully read X-ray photographs and determine the reliability of welds after fifteen minutes of proper instruction.

He further pointed out that the mere possession of a good automatic welding machine did not insure the making of good welds, but that it was necessary also to have an expert and experienced welder in charge of the machine. In his opinion, any thoroughly competent individual welder will make as good a weld, and one just as reliable, as any automatic machine. It is, nevertheless, a fact that the individual welder will tire and his work is likely to suffer accordingly. The length of time that a good welder can operate is dependent largely upon his temperament. Each person must be given individual consideration in this respect.

It was, in the opinion of Dr. Adams, ridiculous to expect the average inspector of boilers, regardless of his knowledge of electric welding, to properly examine and pass upon an electrically welded seam, by observation methods alone, although he may have watched every inch of it being laid and followed the automatic machine from start to finish. He stated that the art of welding is such that it is manifestly unfair to put any inspector under such a responsibility as this.

Tuesday forenoon was devoted to special sessions of the power group, followed by a talk by William G. Christy, smoke abatement engineer, of Hudson County, N. J. Mr. Christy discussed the development of the smoke abatement legislation in Hudson County and the considerations which led to the preparation of the present smoke law under which he is operating. He emphasized the belief that any smoke ordinance should be developed upon broad lines and that all detail information should be covered by a separate book of rules and regulations, so that these may be changed from time to time as the progress of smoke control develops, without in any way requiring the reconsideration of the basic ordinances for the passing of new laws.

George W. Bach, chairman of the Conference Committee on Smoke Prevention, stressed the great desirability of having the smoke regulation requirements dealing with the installation of boilers in various localities under the jurisdiction of engineers and as free as possible of politics, since it had been frequently found a great detriment to attempt to discuss engineering affairs with men who knew nothing of technical matters.

Ely C. Hutchinson, chairman of the recently organized A.S.M.E. Pure Air Committee, reviewed the circumstances which led to the formation of his committee, and stated its objectives. The plans of the new committee were welcomed and the feeling was expressed that the association would be glad to cooperate with its work in the belief that gradually all the various interests dealing with the problem of pure air should find it possible to assemble under the banner of the Pure Air Committee for an exchange of ideas and the unification of progress.

On Wednesday a popular and pleasing tribute was paid to the D. Connelly Boiler Company, which had previously communicated with the association requesting the transfer of its membership to the name of the Foster Wheeler Corporation, of which it is now a part. It was brought out that the Connelly company had been a charter member of

A.B.M.A. members on the first tee at Skytop. Seated are H. H. Clemens (left), president of the association, and F. R. Low (center), editor emeritus of Power

the association at its inception 43 years ago and that ever since that time, first through D. Connelly and later through his sons, had always been a sound, constructive force in the organization. Regret was expressed at the necessity for striking the name of the company from the association roster, but with it the hope that the Foster Wheeler Corporation would continue the splendid example and record of its predecessor.

The officers nominated and elected for the ensuing year are: President, H. H. Clemens, re-elected; vice-president, Sidney Bradford; executive committee, three-year term, Homer Addams, George W. Bach, George S. Barnum; two-year term, Owsley Brown, F. W. Chipman, W. C. Connelly; one-year term, J. G. Eury, A. C. Weigel, E. G. Wein; ex-officio, H. E. Aldrich; secretary and treasurer, A. C. Baker.

Ontario Not Implicated in Beauharnois, Secretary Says

ANSWERING charges leveled at the Ontario Government during the recent Beauharnois development debate in the Canadian House of Commons, Hon. Leopold Macaulay, provincial secretary, addressing a meeting at Simcoe, Ontario, on June 5, emphatically declared that the Ontario Government at no time has had any other relationship with Beauharnois directly or indirectly, than that of a customer seeking to get available power. Mr. Macaulay asserted that the government had no interest in the organization of the Beauharnois company and that if there was any political coloring to the make-up of the company's Board of Directors it was confined entirely to Liberal hues, in the representation supplied to it by Senator McDougald and other members of the Liberal party in Canada.

The provincial secretary's address was almost entirely devoted to a vigorous reply to recent criticism of the Hydro commission's administration and policy. It came, he intimated, as the forerunner of an analysis and digest of Hydro matters which government members from time to time will launch from public platforms with a view to silencing effectively any suspicion or fear which unwarranted statements from antagonists may have created in the public mind.

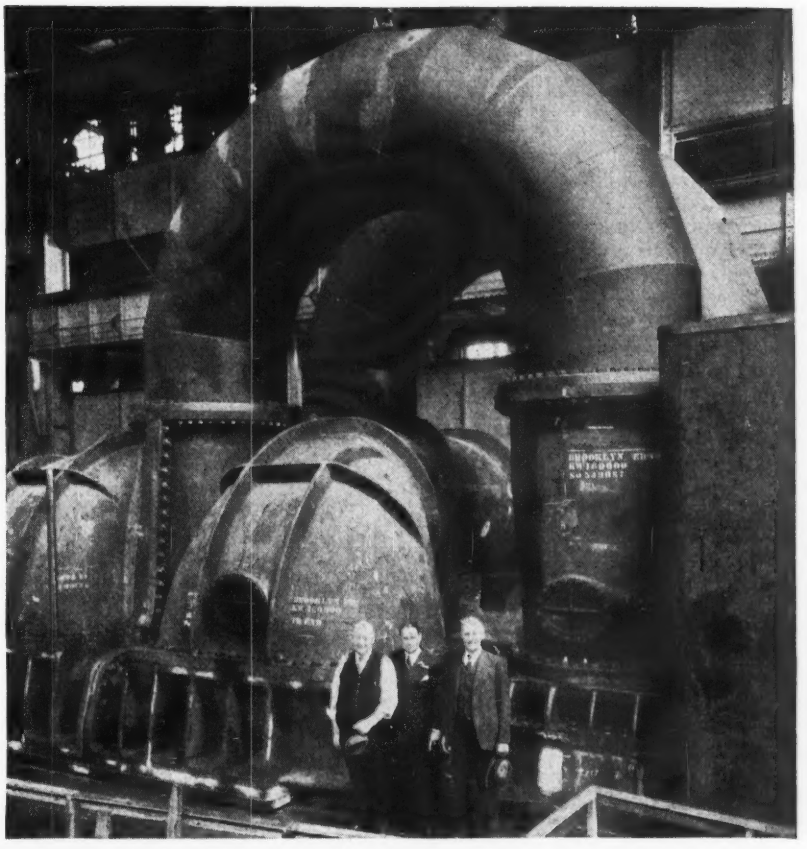
A.I.E.E. Summer Convention At Asheville, June 22-26

A DIVERSIFIED PROGRAM of live technical sessions, unusual sightseeing trips, entertainment and outdoor recreation has been arranged for the annual summer convention of the American Institute of Electrical Engineers, which will be held this year at Asheville, N. C., on June 22 to 26 inclusive, with headquarters at the Grove Park Inn.

Subjects to be discussed at the seven technical sessions include electrical machinery, automatic stations, interconnections, electrical units, cables, research and communication services for electric utilities. Among the papers that will be presented are: "Reestablishing Excitation of a Loaded Alternator in Parallel With Others," D. D. Higgins and E. Wild; "Calculation of Synchronous Machine Constants," L. A. Kilgore; "Determination of Synchronous Machine Constants by Test," S. H. Wright; "Interconnection Services—Their Classification and Evaluation," A. E. Bauhan; "Interconnection—New England District," E. W. Dillard and W. R. Bell; "The Pennsylvania-Ohio-West Virginia Interconnection," H. S. Fitch; "Interconnection Development and Operation," G. M. Keenan.

"An A-C Supervisory Control System," O. K. Marti; "Supervisory Control for A-C Electrified Railroads," C. P. West and H. C. Griffith; "Automatic Combustion Control," C. H. Sanderson and E. B. Ricketts; "Operating Experience With Automatic Stations," F. F. Ambuhl and G. Stamper; "Three Years' Operating Experience With Miniature Switchboard Supervisory Automatic Control," R. M. Stanley; "Extinction of Short A-C Arcs," T. E. Browne, Jr.

MR. SLOAN INSPECTS THE NEW UNIT



A 160,000-kw. steam turbine, one of two being built for the Brooklyn Edison Company, in final stages of assembly at the Schenectady works of the General Electric Company. Standing in front of the machine, left to right, are Charles Palmer, general foreman of the turbine shop, Matthew S. Sloan, president of the Brooklyn Edison Company, and Oscar Junggren, consulting engineer of the General Electric Company

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Gov. Roosevelt Confers With Power Authority

GOVERNOR ROOSEVELT and the five members of the New York Power Authority will inspect the proposed site for the state development of hydro-electric power on the St. Lawrence River the early part of August. This announcement was made June 8 after a conference held at the executive mansion in Albany.

The conference was the first the Governor has had with the authority since he appointed its members last month. Chairman Walsh reported that the authority is getting on very well and is making real progress in getting its organization functioning.

Asked if the authority would shortly announce the appointment of a chief engineer, the Governor stated: "I do not imagine that such an appointment will be made for some time because at present this is not an engineering problem." It is understood the Governor advised the power trustees to enter into negotiations with the Federal and Canadian governments as speedily as possible in the hope of removing legal obstacles which now stand in the way of the proposed development.

J. D. Taylor, Chief Engineer Of N. Y. Museum, Is Dead

WORD has just been received that James D. Taylor, chief engineer and assistant superintendent of the Metropolitan Museum of Art in New York City, died the latter part of April.

Mr. Taylor was born at Red Bank, N. J., on May 23, 1868. He served his apprenticeship at an early age and became an operating engineer. At the time of his death he had held the position of chief engineer and assistant superintendent of the Metropolitan Museum of Art for fifteen years.

Prominently identified with the local and national activities of the National Association of Power Engineers since 1896, he was past secretary-treasurer of the life and accident organization of that body. He filled various chairs and served two years as president of Stevenson Association No. 44. In addition he was secretary and chairman of the combined associations of New York.

He was a member of the American Society of Mechanical Engineers and active in Masonic organizations.

Mine-Mouth Plant Nears Completion at Grand Lake

RAPID PROGRESS is being made in the construction by the New Brunswick Power Commission of its mine-mouth power station at Grand Lake. Erection of this ultra-modern steam plant to utilize New Brunswick coal was authorized by the government a year ago and construction started in the fall of 1930. The station, when completed, will include two 2,500-kw. turbine-generator units, and it can be easily enlarged to greater capacity than the 5,000 kw. provided in the initial installation.

Power from the station will be carried to Moncton over a new transmission line for which steel towers have just been ordered. Some 360 large towers will be required for this line, approximately 65 miles in length. In the direction opposite to that to be taken by the new line, or westerly from the generating station, a high-tension power line has been completed to Fredericton, the provincial capital. For a distance of approximately 100 miles across the central portion of New Brunswick, these lines will supply towns and villages with electric power generated from the province's own coal resources.

Permit Granted for 94,000-Hp. Project on Tennessee River

THE FEDERAL POWER COMMISSION has approved the issue of a preliminary permit to the Southern Industries and Utilities, Inc., for a power project on the lower Tennessee River. This project covers the stretch below Pickwick Landing, near the southern boundary of Tennessee and a point about 20 miles above the mouth of the river. The total length of the pool is estimated to be 190 miles.

The finding of the commission is that the project can be made a part of the comprehensive scheme of improvement of the Tennessee, utilizing its resources for both navigation and power, as well as provide some measure of flood control.

The terms of the permit require foundation examinations to be completed within one year and the preparation of a complete engineering, economic and financial report. The magnitude of this project may be indicated by its estimated capacity of 94,000 primary horsepower and by the estimated cost of the dam and navigation facilities as $46,000,000.

COMING CONVENTIONS

American Society of Mechanical Engineers. National Oil and Gas Power Meeting at the University of Wisconsin, Madison, Wis., June 23-26. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineer. Annual summer convention in Asheville, N. C., June 22-26. District meeting at Lake Tahoe, Calif., Aug. 25-28. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers. Semi-annual meeting at the New Ocean House, Swampscott, Mass., June 22-26. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society for Testing Materials. Annual meeting at the Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

Association of Edison Illuminating Companies. Forty-seventh annual meeting at The Greenbrier, White Sulphur Springs, W. Va., Sept. 21-25. Secretary, Preston S. Millar, 80th St. and East End Ave., New York City.

International Railway Fuel Association. Annual convention at the Hotel Sherman, Chicago, Ill., Sept. 15-16. Secretary, C. T. Winkless, Room 700, La Salle Street Station, Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

Smoke Prevention Association. Annual meeting at the Hotel Pantlind, Grand Rapids, Mich., June 30-July 3. Secretary, Frank A. Chambers, City Hall, Chicago, Ill.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

J. S. TRITLE, vice-president in charge of manufacturing operations for the Westinghouse Electric & Manufacturing Company since 1929, was recently elected vice-president and general manager in charge of manufacturing, sales and engineering operations of the company. Another recent change in the Westinghouse organization is the appointment of GEORGE B. KARELITZ, research engineer, as acting manager of the mechanics division of the company's research laboratories, to fill the vacancy caused by the promotion of JOHN M. LESSELLS to the South Philadelphia works of the company.

LUCIUS B. ANDRUS, president of the Northern Indiana Power Company, has been elected president of the Great Lakes Division of the National Electric Light Association for the term 1931-32, to succeed EUGENE HOLCOMB.

T. HERBERT CLEGG, consulting engineer specializing in the management and supervision of industrial and railway power, has opened an office at 1600 Walnut St., Philadelphia, Pa.

FREDERICK M. FEIKER, managing director of the Associated Business Papers, Inc., for the past four years, has been appointed by President Hoover as director of the Bureau of Foreign and Domestic Commerce, Department of Commerce. For several years Mr. Feiker has acted as a consultant for the department, and when Mr. Hoover was Secretary of Commerce he aided in developing the department's contacts with business and trade. He was at that time associated with the McGraw-Hill Publishing Company, which he served for eight years as an editor and later as editorial director and vice-president.

EDWARD W. LITCHFIELD, superintendent of the New York Power & Light Corporation hydro-electric stations at Ephratah and Cayadutta, has been appointed superintendent of the company's stations at Schaghticoke, Johnsonville, Middle Falls, Victory Mills and Schuylerville in northern New York.

H. H. KURTZ, of the Midwest Stoker Association, has been designated as the representative of the Stoker Manufacturers Association on the Committee of Ten of the Coal and Heating Industries. E. B. LANGENBERG, vice-chairman of the committee and official representative of the National Warm Air Heating Association, has been designated temporarily as the representative of the American Society of Heating and Ventilating Engineers.

C. E. SKINNER, assistant director of engineering of the Westinghouse Electric & Manufacturing Company, has been appointed as the representative of the American Standards Association on the council of the International Standards Association.

Business Notes

INTERNATIONAL PRODUCTS CORPORATION, Milwaukee, Wis., announces the sale of its "Keldur" patent, manufacturing and selling rights and good will to a New York syndicate, which has formed the KELDUR CORPORATION with general offices at 2926 Graybar Bldg., New York City, and a factory at 26 Avenue B, Newark, N. J. W. E. Duersten, president of the International corporation, is vice-president in charge of operation and sales for the new company.

STRONG-SCOTT MANUFACTURING COMPANY, Minneapolis, Minn., announces the opening of its new plant at Taft and Kennedy Sts., Northeast, in Minneapolis. The building is 360 ft. long by 100 ft. wide, affording 72,000 sq.ft. of floor space to house the general offices, engineering department and manufacturing equipment, and represents a total investment of $750,000. An attractive bulletin fully describing the plant has been issued by the company.

AUTOMATIC ARC WELDING COMPANY, New York City, announces that the Babcock & Wilcox Company has acquired non-exclusive licenses to manufacture under its automatic arc-welding patents, the initial payment for such licenses being $20,000.

MCINTOSH & SEYMOUR CORPORATION, Auburn, N. Y., announces the election of John Thomas as vice-president in charge of sales. Mr. Thomas was formerly with the GENERAL ELECTRIC COMPANY, and since last October has been general sales manager of McIntosh & Seymour. The company also announces that it is closing the office at Jacksonville, Fla., and moving it to 910 Seventeenth St., N. W., Washington, D. C.

BOILER ENGINEERING COMPANY, Newark, N. J., has moved its office to larger quarters in the new National Newark & Essex Bank Building, at 744 Broad Street.

THE PERMUTIT COMPANY, New York City, announces the appointment of J. R. Crocker as special Western railroad representative, with headquarters at 215 Pershing Rd., Kansas City, Mo., and the appointment of W. R. Toppan as special Eastern railroad representative, with offices at 1132 McCormick Bldg., 332 South Michigan Ave., Chicago, Ill. Both men have had extensive experience in solving problems related to the treatment of water for locomotive boiler feed, it is stated.

CUTLER-HAMMER, INC., Milwaukee, Wis., has appointed D. J. Quammen manager of the Philadelphia district office to succeed F. J. Burd, who has been made assistant manager of the Chicago office in charge of industrial sales in that district. The company also announces the removal of its Atlanta, Ga., office to 133 Cone St. N.W., with A. C. Gibson, manager.

How's Business?

EARLY JUNE MEASURES of business movement show a slight intensification of the oncoming summer flatness in some lines. But marked and mildly encouraging irregularities are developing in the picture at a time when a fairly uniform let-down might be expected under the prevailing pessimism. Steel activity continues to sag under an accentuated seasonal slump in automotive requirements, though there is nothing abnormal about the decline in output and bookings except the low level from which the changes take place. Building contracts, especially residential, seem to be weakening a little along with power production; but carloadings are holding their seasonal level and coal output is higher.—*The Business Week*, June 17.

Trade Catalogs

ELECTRIC HOISTS—A new 48-page illustrated catalog on electric hoists has just been issued by the Wright Manufacturing Company, Bridgeport, Conn. Complete data is included on hook- and bolt-suspension hoists; plain, geared and motor-driven trolleys; and drum and low-headroom types.

BAFFLE WALLS—A description of a special firebrick tile and plastic material used for repairing all types of boiler baffles is given in illustrated Bulletin BP-31 published by The Engineer Company, 17 Battery Pl., New York.

PUMPS—Four new specification sheets have been issued by the Worthington Pump & Machinery Corporation, Harrison, N. J., on Types LA and LC single-stage volute centrifugal pumps. Sheet W-312-S4 covers 16, 18, 20 and 24-in. sizes; Sheet W-312-S5, 24 and 36-in. LA, 30, 42 and 54-in. LC; Sheet W-312-S7, 36 and 48-in. LA and LC; Sheet W-312-S8, 14, 18 and 20-in. LA, 14, 18, 20, 24, 30 and 36-in. LC. Another new specification sheet, D-112-S13, covers a horizontal duplex double-plunger steam pump.

COAL AND ASH HANDLING—An illustrated folder showing several actual installations of coal and ash-handling equipment has just been issued by the Palmer-Bee Company, Detroit, Mich.

OIL BURNERS—National Airoil Burner Company, 1327 Girard Ave., Philadelphia Pa., has recently issued several bulletins on oil-burning system, as follows: Eighth Edition of the booklet, "Oil Burning in Power Plants"; Bulletin 22 on installation of steam-atomizing oil-burning system; Bulletin 30 on oil-burning accessories; Bulletin 50 on combustion units for use with oil and gas; Bulletin 60 on Type I-R rotary oil burners; Bulletin 70 on Type D-R rotary oil burners; and a brief treatise on "Oil Burning Efficiency."

BEARINGS—Bulletin No. 369 of the T. B. Wood's Sons Company, Chambersburg, Pa., describes and illustrates ball-bearing hanger boxes, drop hangers and pillow blocks.

BELT DRIVES—A new catalog on "Wedgbelt" pulleys and drives has just been issued by the American Pulley Company, 4200 Wissahickon Ave., Philadelphia, Pa. The catalog contains condensed and original information, together with numerous tables, which simplify the calculation of V-belt drives.

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Fuel Prices

FUEL OIL

Boston—June 8, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.91c. per gal.; 28@32 deg., 4.85c. per gal.

New York—June 11, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

Philadelphia—June 6, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—June 3, f.o.b. local refinery, fuel oil, 30@34 deg., 2.5c.@2.75c. per gal.; 36@40 deg., 2.5c.@2.75c. per gal.

Cincinnati—June 9, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—June 3, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 36.25c. per bbl.; 22@24 deg., 40c. per bbl.; 24@26 deg., 45c. per bbl.; 26@28 deg., 52.5c. per bbl.; 28@30 deg., 62.5c. per bbl.

St. Louis—June 8, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.12 per bbl., or 42 gal.; 26@28 deg., $1.195 per bbl.; 28@30 deg., $1.27 per bbl.; 30@32 deg., $1.37 per bbl.; 32@36 deg., gas oil, 2.526c. per gal.; 38@40 deg., distillate, 3.401c. per gal.

Dallas—June 6, f.o.b. local refinery 24@26 deg., 95c. per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.65 @ $1.90
Pool 10, h. gr. low-vol.	New York	1.50 @ 1.65
Pool 11, low-vol.	New York	1.40 @ 1.50
Smokeless, mine-run	Chicago	1.50 @ 1.75
Smokeless, slack	Chicago	.60 @ 1.10
Harlan, Ky., slack	Chicago	1.10 @ 1.20
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.50 @ 1.75
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.25 @ 1.40
W. Ky., mine-run	Louisville	.85 @ 1.25
W. Ky., slack	Louisville	.70 @ .80
Pittsburgh, mine-run	Pittsburgh	1.30 @ 1.60
Smokeless, mine-run	Cincinnati	1.50 @ 1.75
Smokeless, slack	Cincinnati	.90 @ 1.25
Kanawha, mine-run	Cincinnati	1.00 @ 1.35
Kanawha, nut-slack	Cincinnati	.75 @ 1.00
Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.10 @ $3.25
Barley	New York	.90 @ 1.40

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Blytheville—City awarded contract for the construction of a sewage system including disposal plant, two pumping plants, etc. to Volz Construction Co., Baltimore Bldg., Memphis, Tenn. Estimated cost $61,000.

Calif., San Francisco—City is having plans prepared for the construction of a waterworks pipe line over Altamont Pass in Alameda County to connect with west terminus of contemplated pipe line in connection with Hetch Hetchy project across San Joaquin Valley and terminate at a point in the present aqueduct of the San Francisco water department to include pumping plants.

Conn., Hamden—City, will receive bids until June 22 for the construction of a sanitary sewer and pumping station. Estimated cost $50,000. F. W. Wright, Town Hall, is engineer.

Conn., Bristol—Connecticut Light & Power Co., Riverside Ave., will build a 3 story, 60 x 60 ft. steam power plant. Estimated cost $175,000. Work will be done by separate contracts. Contract awarded for structure to G. Lacourse, George St.

Conn., Middlefield—Lyman Farm, plans the construction of a cold storage plant for fruit. Estimated cost $45,000. L. J. Thompson, 521 Corbin Ave., New Britain, is architect.

Conn., Southington — Lakeview Farm, H. Rogers, Mgr., plans the construction of a cold storage plant for fruit. Estimated cost $40,000. L. J. Thompson, 521 Corbin Ave., New Britain, is architect.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., awarded masonry contract for a 1 story, 50 x 71 ft. sub-station at 3147-49 West Harrison St., to T. G. Gage, 64 West Randolph St. Estimated cost $40,000.

Ill., Chicago — Cook County Commissioners, County Bldg., will soon receive bids for the construction of a 17 story nurses' home at Lincoln and Polk Sts. Estimated cost $2,350,000. E. E. Hall, 123 West Madison St., is architect.

Ia., Cedar Rapids — Iowa Railway & Light Corp., awarded contract for addition to power house to T. Stark Construction Co., 118 South 11th St. W. Estimated cost $40,000.

Ia., Vinton—State Bd. of Education, W. H. Gemmill, Secy., State Capitol, Des Moines, is having preliminary plans prepared for the construction of a heating plant for State School for Blind here. Estimated cost $50,000. E. E. Cole, Dept. of Construction, is architect.

Kan., Onaga—City, L. B. Dunn, Clk., voted $45,000 bonds for the construction of a power and light plant.

Kan., Wichita—City, C. C. Ellis, Clk., will receive bids until July 2 for the construction of a sewage disposal plant including screening and pumping station, etc. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., are engineers. Former bids rejected.

Me., West Peru—Berst, Foster Dixfield Co., F. W. Smith, Mgr., is receiving bids for the construction of a 60 x 112 ft. power house and pump house. Estimated cost to exceed $40,000. H. F. Hallock, Oswego, N. Y., is engineer.

Mass., Worcester — Northeastern Storage & Distributing Corp., J. Gerety, 93 Grafton St., is having plans prepared for the construction of a 180 x 640 ft. cold storage warehouse terminal at Grafton and Keefe Sts. Estimated cost $900,000. Howe & Lescaze, 337 East 42nd St., New York, N. Y., are architects.

Minn., St. Paul—City and Ramsey County, G. Bundlie, Mayor, City Hall, received lowest bid for the construction of a city hall and court house, including steam heating system, etc., at Third, Wabasha, Fourth and St. Peter Sts. from Foley Bros., 209 Gilfillan Blk. Estimated cost $3,000,000.

Mo., Kansas City—City voted $1,500,000 for sewers, pumping station and equipment.

Mo., St. Louis—Water Dept., is having preliminary plans prepared for rebuilding and installing new equipment for boiler house at Chain of Rocks pumping station on Mississippi River. $400,000.

N. J., Holmdel — Dept. of Institutions & Agencies, State Office Bldg., Trenton, plans the construction of a group of institution buildings at New Jersey State Hospital. Estimated cost $1,350,000. Division of Architecture & Construction, State Office Bldg., Trenton, is architect and engineer.

N. J., Irvington—Public Service Electric & Gas Co., Terminal Bldg., Newark, plans the construction of a power plant here. Estimated cost $40,000. Private plans.

N. Y., New York — Dept. of Hospitals, Municipal Bldg., will receive bids about July 15 for the construction of a group of buildings including nurses' home, women's pavilion, and power plant at Harlem Hospital. Estimated total cost $2,850,000.

N. Y., Stapleton—Treasury Dept., Office of Supervising Architect, Washington, D. C., will receive bids early in August for the construction of a hospital including steam heating system, etc. at Marine Hospital, Bay St. and Tompkins and Vanderbilt Aves. here. Estimated cost $2,500,000. K. M. Murchison and W. H. Compert, 101 Park Ave., New York, are architects. Taehan & Vought, 102 East 30th St., are associate architects.

N. Y., Watertown—Beebe Island Power Corp., G. Seymour, Pres., Phelps and Hudson Sts., awarded contract for the construction of a power plant, two units of 5,000 hp. each to F. T. Ley & Co., 1215 Main St., Springfield, Mass. Estimated cost $591,000.

N. D., Fargo—State Bd. of Adminstration, E. G. Wanner, Secy., Bismarck, is having plans prepared for improvements and alterations to central heating plant including 400 hp. standing type boiler, traveling gate stoker, coal handling equipment, also constructing smokestack, 125 ft. high and 5½ ft. in diameter. $50,000. Fuel Economy Engineering Co., 400 Anchor Insurance Bldg., St. Paul, is engineer.

O., Cleveland—Juvenile Court Building Commission, J. H. Harris, Chn., Court House, will receive bids until July 2 for the construction of a juvenile detention home, court building, department building, service building, etc., including steam heating system, etc., at East 22nd St. and Central Ave. Estimated cost $1,650,000. F. W. Bail Co., Hanna Bldg., is architect.

Okla., Supply—Western Oklahoma Hospital, c/o State Bd. of Affairs, State House, Oklahoma City, is having preliminary plans prepared for the construction of a hospital including power plant. Estimated total cost $210,000.

Pa., Erie—Erie County Electric Co., 12th and French Sts., awarded contract for the construction of a 28 x 35 ft. sub-station at Peach and Cherry Sts., to H. Platt Co., 1006-8 Palace Hardware Bldg. Estimated cost $40,000.

Pa., Titusville—Titusville Dairy Products Co., H. Rabild, Pres. and Mgr., is receiving bids for a 1 story, 15 x 20 and 20 x 20 ft. plant including boiler house on South Washington St. Braziell & Anderson, 309 4th Ave., Pittsburgh, are architects.

Tex., Beaumont—Sun Pipe Line Co., Philadelphia, Pa., and Yount-Lee Pipe Line Co., San Jacinto Life Bldg., Beaumont, (joint owners), plan the construction of two pumping stations in connection with oil pipe line from Texas fields to Tidewater near Beaumont. Total estimated cost $2,500,000. Private plans.

Tex., Harlingen—Texas Frozen Juice Corp., plans the construction of a plant to freeze citrus, also packing plant. Estimated cost $65,000. Private plans.

Vt., Bennington—State of Vermont, H. T. Johnson, Montpelier, is receiving bids for the construction of a heating plant, including two new boilers, and radial chimney at Soldiers Home here. Estimated cost $50,000. F. L. Austin, 240 College St., Boston, Mass., is architect. A. S. Kellogg, 585 Boylston St., Boston, is engineer.

Wash., Seattle—James A. Wetmore, Supervising Architect, Washington, D. C., awarded contract for the construction of a 16 story hospital on Beacon Hill here to N. P. Severin Co., 222 West Adams St., Chicago, Ill. Estimated cost $1,500,000.

Que., Montreal—Reverend Sisters of the Grey Nuns, Queen Mar Road, awarded contract for the construction of a 62 x 100 ft. power house to A. Deschamps, 156 Maplewood Rd. Estimated cost $66,000.

Equipment Wanted

Condenser—Pasadena, Calif.—City will receive bids until June 26 for furnishing and installing steam condenser, 2-pass steel plate surface with unequal circulating pumps and appurtenances for municipal light plant.

Engines, Generators, etc.—Vermilion, S. D.—City will receive bids until June 29 for engines and generators, switchboard, motor driven exciter and auxiliary electric equipment for proposed municipal electric light and power plant. Estimated cost $85,000.

Generator, Condenser, etc.—Holdrege, Neb.—City, I. Anderson, Clk., will receive bids until June 25 for a 600 kw. turbo-generator, surface condenser, switchboard panel, sump pump, feed water regulator, superheater, 315 hp., etc.

Generating Unit—Litchfield, Minn.—City, M. Mortenson, Recorder, will receive bids until June 22 (extended date) for furnishing and installing 750 kw. steam turbine generating unit with condenser, generator, cooling tower, also unaflow reciprocating engine and generator unit.

Ice Plant Equipment—Hillsboro, Tex.—W. S. Grimes and W. D. Little, want quotations on equipment for proposed 60 x 90 ft. ice plant. Estimated cost $60,000.

Pump and Motor—Magnolia, Ark. — Bd. of Trustees, A. & M. College, C. A. Overstreet, Pres., will receive bids until June 24 for a 150 g.p.m., 250 ft. head centrifugal deep well pump and 20 hp. motor.

Pumps—Calexico, Calif.—City will require 100 g.p.m. motor driven pumps in connection with proposed waterworks.

Pumps—Millstadt, Ill.—City will receive bids about July 1 for a motor driven deep well turbine pump, one motor driven and one engine driven high service pumps, etc., for proposed waterworks improvements. Former bids rejected.

Pumps—Greenwich, O.—City, will receive bids until June 19 for installing two centrifugal pumps for proposed waterworks pump house. Estimated cost $30,000.

Industrial Projects

Mass., Taunton—Taunton Pearl Works, 35 Vernon St., will receive bids until June 19 for the construction of a 2 story factory on Ingell St. Estimated cost $50,000. Jackson & Moreland, 31 St. James Ave., Boston, are architects. Former bids rejected.

N. J., Newark—Bd. of Commissioners, City Hall, is having plans prepared for the construction of a 1 story, 100 x 140 ft. factory at Port Newark. Estimated cost $40,000. Architect withheld. Reliable Box & Lumber Co., 65 Ava. A., is lessee.

N. J., Newark—John C. Kokaut, Inc., 117 Green St., postponed construction of 3 story, 50 x 100 ft. woodworking plant on New York Ave. $40,000. W. Snyder, 790 Broad St., Archt. Maturtiy indefinite.

N. Y., Brooklyn—Rand Rubber Co., Halsey St. and Sumner Ave., is having sketches made for addition and alterations to factory. Estimated cost $40,000 including equipment. M. Marlo, 200 Beverly Rd., is architect.

N. Y., Buffalo—A. F. Oliver Gear & Machine Co., Inc., 60 Cherry St., plans the construction of a 1 story, 85 x 250 ft. factory at Niagara Sq. and Albany St. Green & Son & Hopkins, 1 Niagara Sq., are architects.

Pa., Philadelphia — Boyertown Burial Case Co., E. L. Mory, Pres., 1211 Arch St., will soon award contract for the construction of a 3 story, 34 x 112 ft. factory at Florist and Juniper Sts. Estimated cost $75,000. Private plans.

W. Va., Chester—Harker Pottery Co., East Liverpool, O., awarded contract for the construction of a 200 ft. tunnel kiln to Harrop Ceramic Service Co., 310 West Broad St., Columbus, O., also 1 story, 140 x 200 ft. factory to house new tunnel kiln to Finley Bros. Lumber Co., Chester. Estimated cost $100,000 and $50,000 respectively.

Ont., Guelph—Sunshine Products of Canada Ltd., T. H. H. Orr, Pres., plans the construction of a plant for the manufacture of liquid wax polishes, oils, etc. Estimated cost $50,000.

Ont., Hamilton—Pennsylvania Refinery Co. (Canada), Ltd., plans the construction of a refinery. Initial cost $100,000.